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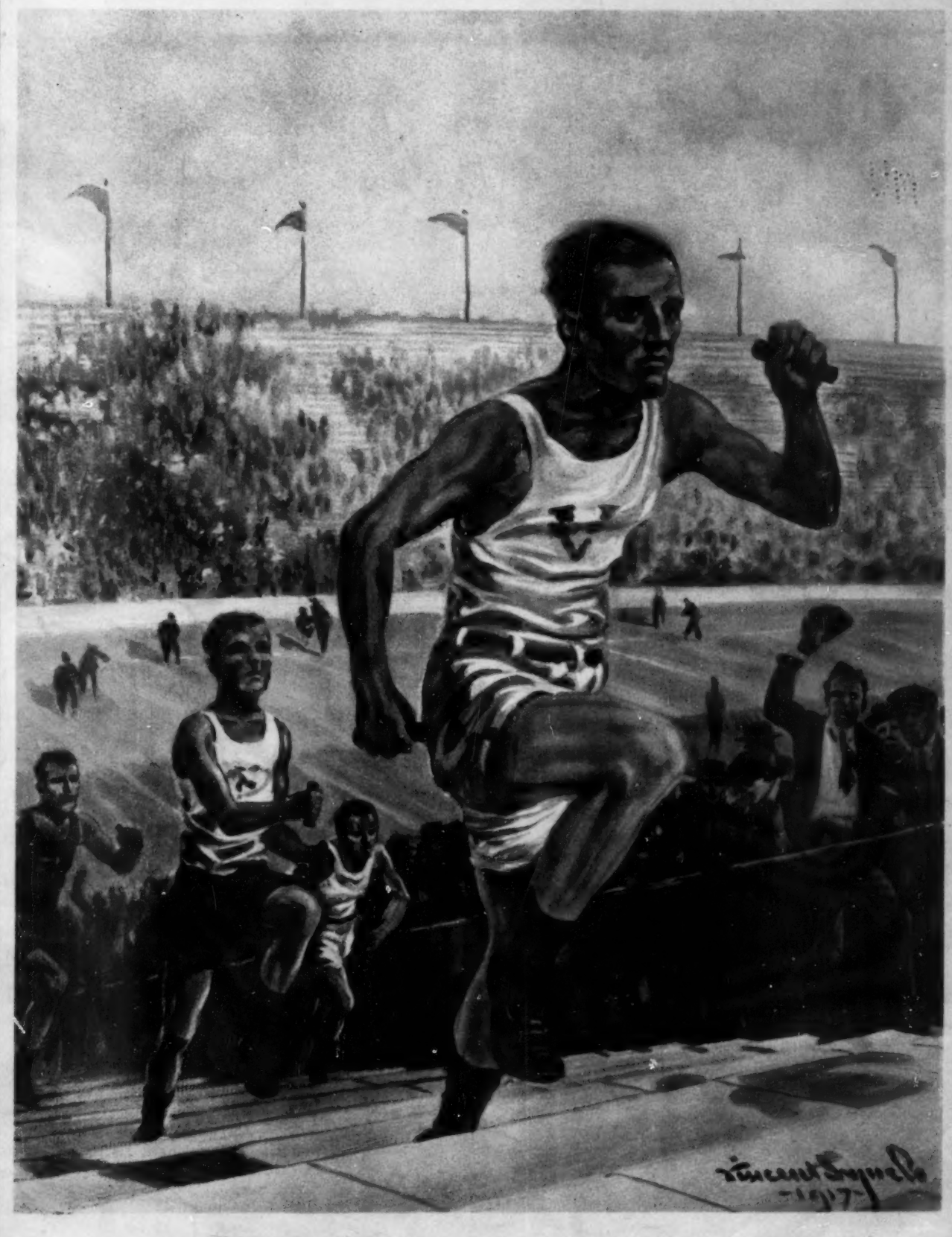

A HORSE-POWER RACE: THE MAN WHO DOES THE MOST WORK WINS THIS CONTEST—[See page 12]

July 7, 1917

Munn & Co., Inc., Publishers
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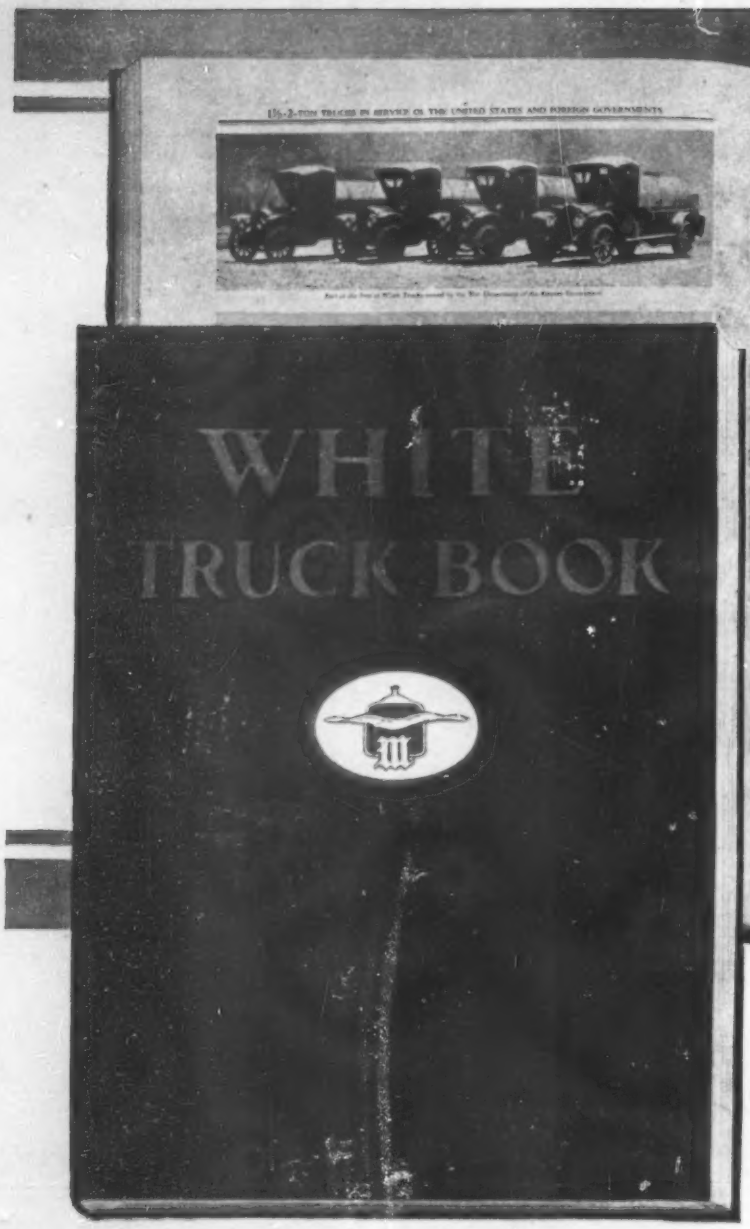

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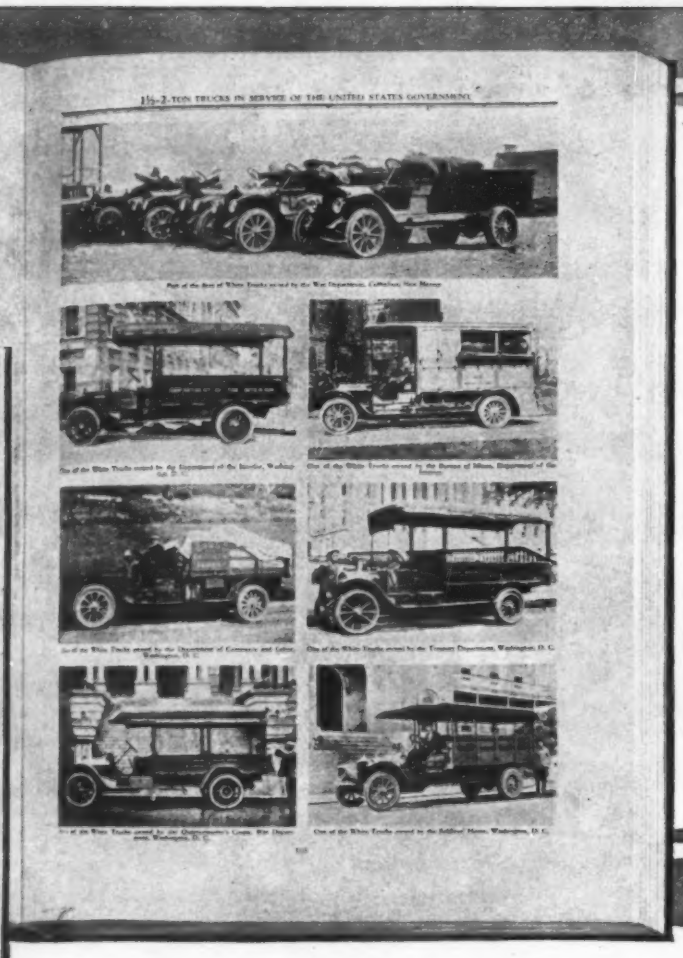

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SEVENTY-THIRD YEAR

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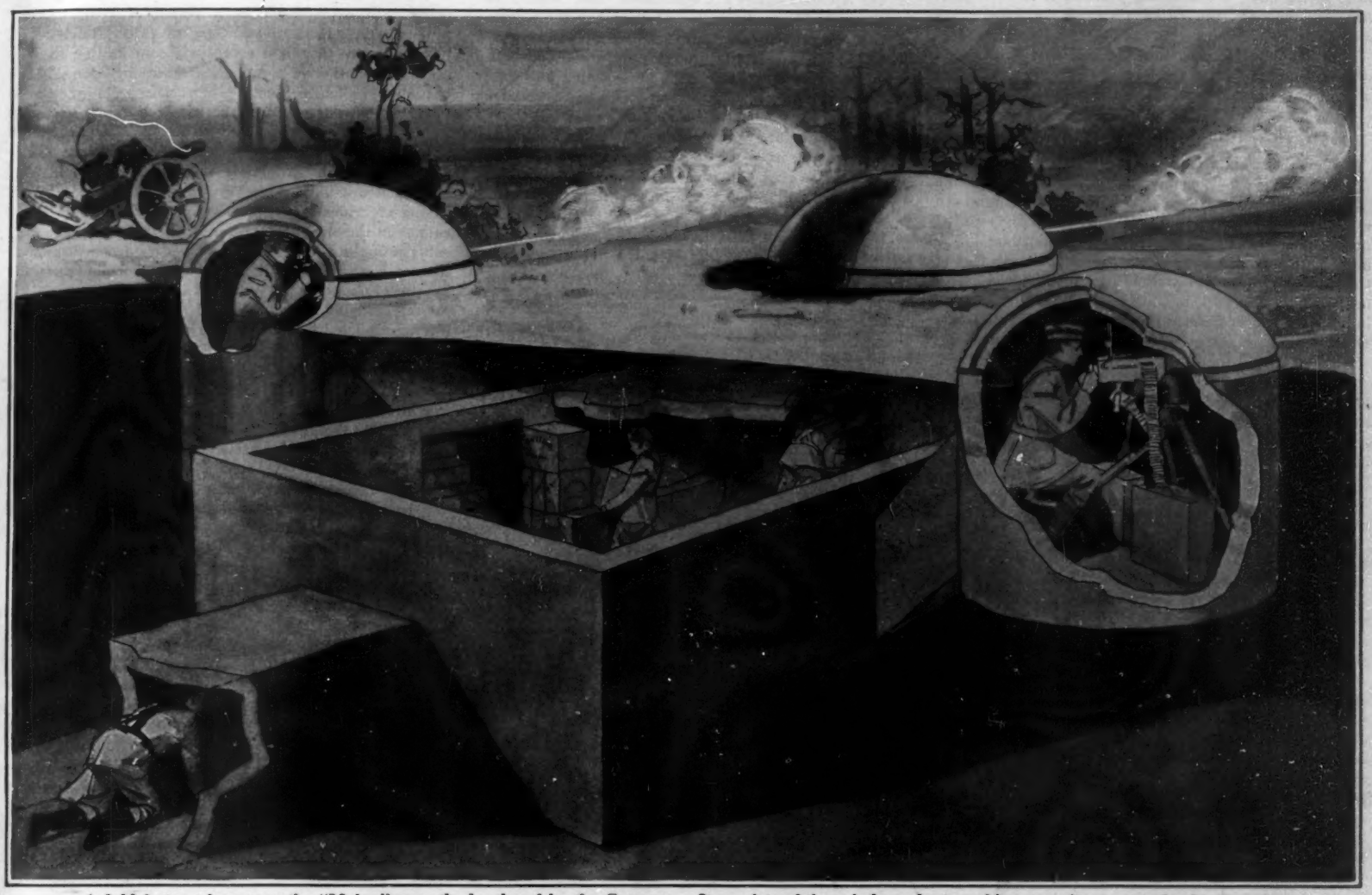

A field fortress known as the "Mebu," recently developed by the Germans. It consists of three independent machine-gun pits, a central subterranean chamber which serves as a storeroom and shelter, and a long passageway to the rear

Re-introducing the Concrete-and-Steel Fortification

EARLY in the war when the hail of steel and high explosive from German howitzers was poured upon the fortifications of Liege, Namur and Antwerp, reducing them to chaotic ruins in short order, it was acclaimed by military experts that the day of the permanent fortress was past. Concrete and steel were of no avail against the power of modern artillery; and henceforth an army on the defensive would have to rely on earthworks and the usual run of field defenses for protection against an enemy superior in numbers and equipment. This opinion was taken for granted: the first and second year of the war witnessed both sides making use of earthworks to an unprecedented degree. But, beginning with the battle of the Somme, the Germans—and the Allies to some extent—began to revert to the former concrete-and-steel defenses which they themselves had pronounced useless when their big guns were irresistibly paving the way for their gray-clad legions in those dark days of August and September, 1914.

So the concrete-and-steel fortification is again in the good graces of the military men of Europe. During the recent advances of the British and French forces in France, numerous artfully concealed shelters for German artillery, machine guns and men have been discovered in the Hindenburg line, and it is these isolated little forts which have made it so difficult and costly for the Entente infantry to advance. Typical of the German defense works is the machine-gun emplacement shown in the accompanying photograph, which the advancing French troops discovered in the region of Soissons. Little blockhouses, such as this, are made of concrete reinforced with steel rods and beams, and rise from four feet to eight feet above the ground. The front face of the blockhouses is usually about four feet thick, while the side walls are two feet thick and the rear wall is considerably less, if not built of plain brick. The front or fighting face is provided with a long horizontal slit some three or four feet above the ground, so that the machine gun can be played horizontally and at such a height that its fire will be in line with the breasts of advancing infantry. As a protection against flying shell splinters and shrapnel, some German blockhouses are provided with sheets of armor plate and heavy screens which are placed where they will afford the maximum protection to the occupants.

A typical reinforced concrete machine-gun blockhouse of the Germans, found in a captured section of the Hindenburg line

A far more elaborate form of defense has recently been employed by the Germans, and it is most suggestive of the ante-bellum fortresses with their Brialmont cupolas. This last word in military engineering is known as the "Mebu," which is derived from the initial letters of its German designation, "Maschinen Eisen Betun Unterstand," which means an underground concreted machine-gun position. A typical Mebu appears in the accompanying wash drawing, and a careful study will reveal the general details of this novel field fortification. Essentially, the Mebu consists of three independent machine-gun pits connected with a central

(Concluded on page 19)

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

Morality at Newport

IF ever there is a time when discretion is called for, surely it is when a country is undergoing the extreme ordeal of war. Hence we consider that the publicity given to the recent "tea-table" gossip about the reputed irregularities of the Reservists at Newport is simply deplorable. We do not refer to the recent statement of the Secretary of the Navy respecting the vice conditions in the *city* of Newport, but to the statements of private individuals which directly impute to the Naval Coast Defense Reserve stationed at Newport both immorality and inebriety.

If the thing were true, which it is not, and those who have wagged their tongues so foolishly had been actuated by a sincere desire to better conditions at Newport, about the last thing they would have done would have been to rush into print; rather, they would have made their complaint direct to the officials concerned, and they would have done that, only after the most careful investigation, on the spot, of the actual conditions.

Now, the SCIENTIFIC AMERICAN, through its Editorial staff, has made a personal investigation of these rumors, and we are in a position to affirm that the statement that immoral conditions have prevailed among the Reservists is as untrue and unjust as it is detrimental to the Recruiting service, which is working so hard, just now, to bring the Newport Reservists up to their full quota.

There is no more definite gage of the truth or falsity of such statements than the medical records of the military or naval organization which is subject to such charges. In the instance under discussion, the medical records of these young men, who have volunteered for the service of their country, prove that they are almost phenomenally free from those forms of sickness which result directly from immoral life, the actual figure being less than four-tenths of one per cent. Furthermore the reports of the Chief of Police of Newport and of the U. S. Secret Service operatives at Newport, unequivocally disprove the rumors.

It is wholly conceivable that this attempt to discredit these splendid young patriots is merely a fresh manifestation of the widespread and sinister efforts of German propagandists to hamper our naval and military preparations.

The Cantonments for Our National Army

ON June 5th we registered 10,000,000 men for military purposes. Five hundred thousand of these will be at once selected for our new National Army. The first thing to be thought of in this army after selection is training and to train properly we must have camps, cantonments, as they are called. With our 500,000 new recruits there will be officers and extra men enough to make a body of over six hundred and twenty-five thousand, to be divided into groups of 40,000 each. This means that by the first of September we must have ready for our Army sixteen cantonments or towns. No such task was ever undertaken before in twelve weeks. In three months more money will be spent than went into the Panama Canal in the course of any one year. These towns cannot be the old-fashioned camps. It is not tolerable that they shall not have ample water supply and the best of sewerage and have it when the boys arrive; but they must have also streets, a railroad, barracks for the men, and quarters for the officers. Each will be a town of about one thousand houses as now planned, and all this construction, as far as essentials go, must be ready by the first of September. Every resource of the Quartermaster's Department, which has charge of this great work is being strained, and to supplement and advise the Quartermaster's Department the Council of National Defense has appointed an Emergency Construction Committee. Probably the ablest men in construction work in this country are today gathered in Washington in this advisory capacity. We have there the best of our city planners and water experts, working without pay, and most of them nearer twenty-four hours a day than twelve.

The plans for the great undertaking are ready. The materials are in sight. Of course the quantities of all materials are enormous. Thus each camp will require over thirteen hundred car loads of lumber, something like twenty-six million feet. In all, 3,800 carloads of materials must be delivered for each cantonment.

As we go to press the contracts are being let for the construction work. The War Department has decided upon a policy of absolute and continuous publicity in the building of these cantonments, and it is anxious that at the start the public, which is so vitally interested in having these cantonments healthy places for the boys going into them, should understand clearly why they have adopted the form of contract they have and what safeguards they are following in letting the contracts. If the Quartermaster's Department had leisure the practice which has always been followed in the Government would prevail now, that is, full specifications would be written out and the Department would advertise for bids. The contracts would be awarded only after the most careful consideration and the work would be done on what is called a "lump sum bid." Obviously there is no time for any such leisurely work in the present emergency. It is of the most vital importance to the men we are to train that this work shall be pushed with all the speed and efficiency of which the building forces of this country are capable.

Now these conditions have led the Advisory Committee of the Council of National Defense to counsel the Quartermaster's Department to make contracts on the percentage basis. But in doing this, all sorts of precautions and checks have been provided in order that only the ablest and most honest contractors shall be given contracts. To begin with, a full set of questions have been sent, confidentially, to all the leading contractors of the country. They are asked to tell of the work they have done in the last three years; its size, etc. They are asked to tell how large a number of men they are prepared to keep in camps; that is to say, a pretty good history of their operations is required, with references. In addition to this, confidential questionnaires have been sent to leading engineers and architects asking them about each contractor, his integrity, his reputation for finishing work on time, his equipment, etc. These sets of answers have been put into the hands of one of the best judges of contractors that is known in this country. It has long been his business to judge contractors for great security and guaranty companies. He goes over the questions and then gives the Quartermasters' Department his judgment as to whether the contractor's offer is so sound that this gentleman would be willing to advise his fidelity and guaranty company to go on the contractor's bond. In addition to this supervision the Quartermaster's Department has its own representatives, assisted by civil engineers, who will supervise every detail of the construction work on the ground. If anything more can be done the War Department is prepared to do it; but we are free to admit that it looks as if as perfect a set of checks has been provided as could be devised.

The contracts are made on a seven per cent basis to cover overhead costs and contractors' compensation, with an upset limit of $250,000. Before anyone decides this is too much and quotes some contractor who says that he would be glad to do the work without profit, he should look more closely into the case. On an average, it is estimated that all of these contractors have an overhead charge of three and one-half per cent. This means that on a million dollar contract the contractor earns $35,000, and certainly nobody ought to complain at that. It is not the policy of the Government in this crisis to allow a man to do work of this kind without profit. Business must be kept stable and the worker must have his fair wage, and in the case of the contractor, profit is his wage. The War Department bespeaks of the country in this great undertaking both its sympathetic understanding and its active coöperation. Useful suggestions will be welcomed; but this is the country's work and the whole country should combine courageously and understandingly to see that it is put through, as far as essentials go, on time.

The Basis of Reform

THE Great War in Europe is an admission of failure. Man's attempts to build up a truly civilized state have obviously been realized only to a very imperfect extent. In this remark we are completely ignoring the theory, prevalent in Germany, that war is a biological necessity, and an inevitable concomitant of any highly developed community. We ignore the theory because we think it expresses a contradiction; we refuse to admit that a community is really highly developed if that community, for the purpose of spiritual development, is always waging wars. But, apart from the example furnished by the war, it has always been apparent to students of the subject, that our so-called civilized communities are still in a very rudimentary condition. The prevalence of avoidable misery, and the direct encouragement afforded by society to all kinds of morally unworthy activities, are such prominent features of every modern community, that only a very strained use of the word "civilization" would make it truly applicable to such communities.

On this point most people are now agreed and, as one consequence of the war, we are asking one another to a quite unprecedented extent, how this state of things can be altered. We have many past failures to warn us against facile theories. In the first days of the French Revolution the most sweeping changes in the method of government were effected—and we know how rapidly those reforms collapsed. The next great attempt at social reformation on a big scale will, in the opinion of many observers, probably take place in England. The social reformer after the war will have many advantages. He will have the great advantage of being in possession of a great mass of constructive criticism, the work of many men extending over a period of years. Continental and American and English writers have been busy for more than half a century, contributing to one aspect or another of the general question. Some have contributed scientific analyses of various social questions (the body of writers connected with the Fabian society, for instance) and others, by flashes of imaginative insight, have more clearly defined the problems which must be tackled. All kinds of movements are in the air: men are alive with curiosity and imbued with a feeling of impending change. And yet, desirable as a change in the structure of society has been found to be, every proposal which has so far been framed is attended with a class of dangers of which most reformers seem to be entirely ignorant. We must not be understood to be discouraging attempts at any immediate change, but in pointing out that the solutions proposed are merely partial solutions, we wish to call attention to certain fundamental characteristics of the general problem.

Using mathematical terminology for a moment, we may say that while most writers regard various human qualities as independent variables, psychological research shows that the variables are not independent. In other words, if a state is organized and laws enforced with the object of encouraging certain human qualities which all are agreed to be desirable, it does not follow that such laws develop *only* those qualities to which they were intended to apply. Similarly with suppressive laws. Laws intended to suppress certain undesirable qualities may, and very likely will, suppress at the same time very desirable qualities. Man's wishes and vices are not united together in his personality as sticks are tied up in bundles, but rather as various parts are coördinated in an elaborate mechanism. Most schemes of social reform hitherto propounded are altogether too repressive in tendency, and for the reason that their repressive influence does not stop short of the qualities it is desired to repress. The Socialistic philosophy of such a writer as Mr. H. G. Wells, for instance, is quite justly criticised by Mr. G. K. Chesterton as making the world a remarkably dull place, and giving very little scope for the more romantic and adventurous manifestations of human instinct. On the other hand Mr. Chesterton's own philsophy suffers from a lack of common sense. Even the abolition of his "*bete-noir*," the "scientist," would not benefit the world to the extent he supposes. Nor would the abolition be permanent. There would always be individuals who preferred wondering why beer froths at the top, to drinking the beer.

Considered scientifically then, we say that in spite of all the work which has been done, the creation of an ideal state is at present impossible. The work done is the merest fraction of the work which remains to do before the ideal state can be constructed. Utopias are worthless, because they are founded on very limited, and probably erroneous, estimates of the possibilities of human development. The science which matters most in this connection is the science of psychology, the youngest of the sciences. Its positive results are so far few, but at least it widens our notions of possibility, and warns us against specious generalizations. All attempts at reform at present should be in the direction of acquiring greater flexibility in the social organism, not in the direction of a definite system. We want incessant criticism. We must question even our axioms. To read some writers one would imagine that the problem of constructing an ideal state was not much more complicated than the calculation of planetary orbits. As a matter of fact, it is so complicated that it *may be* for ever insoluble. So many factors have to be taken into account, that, even were that all, the problem would be almost hopelessly involved. But that is not all. There are tendencies in human nature which may render an ideal system for ever impossible. Man will always insist on the freedom of his will; and as that very subtle psychologist, Dostoievsky, says: "Man loves to act as he *likes*, and not necessarily as reason and self-interest would have him do. Yes, he will even act straight against his own interests." This curious kink in our human material may for ever doom all systems to futility, but that does not exonerate us from the obligation to act as if our exertions would ensure success.

Electricity

The Efficiency of Optical Projection.—In a recent paper before the Illuminating Engineering Society, Mr. R. B. Chilas analyzes the conditions affecting the efficiency of optical projection in the cinematograph projector. He estimates that in the most favorable circumstances the screen does not receive more than 5.8 per cent of the light from the arc, while in many cases it does not exceed one per cent. Various arrangements of carbons with a view to avoiding the shadow cast by the negative have been tried, but with the present lens systems it is difficult to utilize more than 17 per cent of the light from the crater. On the other hand, it is suggested, an improvement might be made by reverting to an old idea explained in a Swiss patent, by S. Schuckert, as far back as 1889. This involves the use of an ellipsoidal mirror, the crater being at one focus, the objective lens at the other, and the film in between. Theoretically as much as 75 per cent of the light from the crater might thus be collected.

An Arc-Heated Soldering Iron.—Some time ago there appeared on the market a soldering device consisting of two high-resistance electrodes which, when applied to a piece of metal, heated the work in hand in a few moments' time. This device operated on the electric arc principle. Operating on a similar principle but applying the electrodes to a soldering iron instead of to the work, a new copper-pointed soldering iron has been developed. This latest device is designed for tinning, running of seams and soldering of low-fusing metals such as zinc and lead. The copper point is brought in contact with the carbon electrodes by releasing a lever, which is spring-operated, this operation being facilitated by lessening slightly the grip on the handle and tightening again. The new iron is obtainable in two sizes, 60 watts and 150 watts; and the supply current is stepped down by means of a transformer to only 5 to 7 volts for the arc. It is said that the iron may be heated ready for use in two minutes.

Testing Internal Combustion Engines with the Oscillograph.—In the *Revue Généralé d'Electricité* M. Camillerapp describes an interesting application of the Blondel oscillograph. In studying internal combustion motors it is desirable to record (*a*) the pressure variations in the cylinder, (*b*) the period between two explosions, giving the speed of the engine, and (*c*) the magnitude and duration of the ignition current. By means of oscillographic methods (*b*) and (*c*) can be readily followed. A special device has been designed for studying (*a*). For this purpose a microphone, in electrical connection with an oscillograph, is mounted in the cylinder. In view of the high temperature of the cylinder gases, the latter are only allowed to impinge on a mica disk, which, in turn, communicates its variations through a metal needle to the disk in the microphone. In order to minimize the effect of vibrations it is convenient to mount a second microphone, back to back with the microphone registering the pressure, so as to be affected by mechanical vibrations only and not by pressure fluctuations. The two microphones are then connected up on the Wheatstone bridge principle so that the vibration effects cancel out. The three factors (*a*), (*b*) and (*c*) can be studied simultaneously and the oscillograph method of attack is expected to throw light on many debatable questions in this field.

High-Frequency Reisistance of Multiple-Stranded Insulated Wire.—Speaking recently before the Royal Society, Prof. W. O. Howe brought out a number of interesting observations with regard to the high-frequency resistance of multiple-stranded insulated wire, which subject is of particular interest to radio engineers. In his paper Prof. Howe points out that the object of such wires in high-frequency circuits is twofold, viz., to make the inductance independent of frequency and to reduce the resistance at high frequencies. It is shown in this paper that the second object is rarely achieved because of the eddy currents induced in the wires by the magnetic flux within the conductor. It is shown that the loss due to this cause is so great that the effective resistance of the stranded conductor is, in many cases, greater than that of the solid wire which could be put in its place. In the first part of the paper formulae are deduced on the assumption that the eddy currents in the fine wires do not appreciably affect the distribution of magnetic flux within them. In the second part this assumption is not made and formulae are deduced which take into account the screening effect of the eddy currents. It is proved, however, that the assumption is permissible in nearly all the cases considered. A number of tables are given showing the ratio of the high frequency to the continuous current resistances of straight and coiled conductors of different sizes made up of fine wires of three alternative diameters. These formulae and tables enable one to see at once if any advantage is to be gained by using such a stranded conductor in any given case, and if so, the best number of wires and space-factor to employ. The paper shows conclusively, however, that the extended use of such conductors in radio-telegraphy for the purpose of reducing the resistance has no scientific justification.

Science

A Southern Hemisphere Astronomical Yearbook.—The National Observatory of Rio de Janeiro has just published its *Annuario* for 1917—the thirty-third volume of this useful yearbook. Works of this character are rare in the southern hemisphere, and it therefore seems worth while to call attention to the fact that a comprehensive astronomical almanac, with tables computed for the latitude and longitude of Rio and various magnetic and other geophysical data for Brazil, is issued yearly by the enterprising institution of which Dr. Henrique Morize is director. The present issue contains, exceptionally, a digest of meteorological observations made at 27 stations in Brazil during the years 1911-1915.

A Colonial Institute in Amsterdam.—A noteworthy recent undertaking in Holland is the establishment at Amsterdam of a colonial institute commensurate with the great colonial interests of the country and representative of the part which Holland has taken in promoting research in tropical agriculture and kindred subjects. The institute comprises three sections. One of these is an economic section, formed by the transfer from Haarlem of the collections and staff of a colonial museum formerly located at that place. The second section is devoted to anthropology, and the third to tropical hygiene. The last of these will coöperate with the hygienic institute of the University of Amsterdam, and will be housed in a special building at the university.

The Whitby Jet Industry.—The American consul at Hull, England, reports an interesting revival of the jet industry which has been carried on at the town of Whitby since before the Norman Conquest, but which had nearly died out in recent years, partly owing to the competition of glass imitations of jet made in Germany. The war, besides cutting off the supply of these imitations, has thrown the nation into mourning and thus greatly increased the demand for black ornaments. The industry was most prosperous in the period from 1850 to 1880, when it gave employment to some 1,500 men and boys. The jet mined at Whitby is said to be much superior to that produced in Spain, much of which, in former years, was brought to Whitby to be manufactured. Most of the workers now engaged in carving, turning and polishing jet in the Whitby factories are old men who learned their trade in the days when the industry was at its height.

Pruning and Ringing of Apple Trees.—Messrs. Alderman and Auchter, of the West Virginia Agricultural Experiment Station, have made a preliminary report on experiments in pruning apple trees, extending over a period of four years. The purpose was to study the effects of various degrees of dormant pruning, summer pruning at different times, and combinations of dormant and summer pruning. The general result is that although heavy annual dormant pruning has produced stronger terminal growth, the gain in the total length of growth and in increase in trunk diameter has been less than with light pruning. Heavy dormant pruning stimulates fruit production in middle-aged trees that are only in a fair state of vigor. Dormant pruning has proved superior in its results to all forms of summer pruning. Experiments were also made in ringing, with the result that ringed trees produced heavy crops the season following the operation, but exhausted the trees to such an extent that no crops were produced during the next two years.

Galatic Structure of Globular Star Clusters.—The real nature of the great globular star clusters is still enigmatical. The opinion still prevails that they are enormously distant, and constitute stellar systems distinct from the one to which our sun belongs. The question whether they exhibit galactic planes like that of our system has recently been raised by Messrs. Pease and Shapley. Quantitative studies of the distribution in clusters have hitherto been confined almost entirely to the relation of the number of stars to the distance from the center, and not to the direction from the center. The investigation in question consisted of star-counts on a series of photographs of clusters made with the 60-inch reflector of the Mount Wilson Observatory. More than half a million stars were counted and tabulated with respect to their positions around the center. Galactic planes should reveal themselves through an elliptical distribution of the stars, and of nine clusters examined, five showed an elliptical form. Three were sensibly circular; *i. e.*, the density was similar in all directions from the center. The interpretation suggested for these cases is that the galactic poles lie approximately in our line of sight, and this hypothesis is made more probable by the fact that the three clusters in question are noticeably less condensed than those showing an elliptical form. Axes of symmetry in the clusters studied do not appear until the arrangement of several thousand stars is analyzed. The failure previously to detect the ellipticity, amounting in some cases to nearly 30 per cent, must be ascribed to the influence of the brighter stars, which, in general, do not show elliptical distribution.

Automobile

Stands for Tire Changing.—It is so unpleasant to crawl under a car to place a jack, when a tire change has to be made, and so difficult to find a proper lodging place for the jack on the under gear, that it has been suggested that a stand, similar in operation to those used on motorcycles, be fitted. With such a stand the car could be jacked up by its own power, and much trouble and annoyance avoided. It would seem that such a stand would be rather heavy and cumbersome, but possibly some genius could overcome these objections.

Automobiles Cause Pavement Troubles.—That road engineers have something still to learn in meeting new conditions created by the wide use of motor vehicles is shown by the experience on the Queensboro Bridge, in Manhattan. The roadway first put down was of wood blocks laid on a concrete foundation, and it was but a short time before trouble began to develop. One of the most noticeable features of the effect of motor traffic on the up-grades was that the traction of the wheels displaced the paving blocks, crowding them backwards in some cases eight to twelve inches. Naturally the surface soon began to disintegrate, and the entire paving on the approach grades had to be reconstructed. Other troubles and defects also developed, and in constructing the new roadway entirely different methods were developed which promise to be successful.

Quick Acceleration.—A favorite recommendation in selling a car is that it will pick up speed very rapidly; but it would seem that both dealers and manufacturers are working against their own interests in suggesting such methods of operation to users of cars. To accelerate a car weighing over a ton from five miles an hour to forty miles in fifteen or twenty seconds means a tremendous strain on every portion of the machine, with consequent rapid deterioration, and is especially destructive of tires. Moreover, there is no reasonable advantage in the procedure, for the time gained thereby could hardly be measured with a stop watch in a day's run. The result is attained by supplying a much greater power than the user has any need for, and the principle use made of it is to jump across the track in front of trolley cars and railroad trains. Once a year it might save a man's life, but even then it would not be necessary if ordinary precaution is observed in driving. In the meantime the car owner is paying for a lot of gasoline consumed by the excessively large engine, which has been of no benefit to him.

Agricultural Tractors.—The world has suddenly awakened to the necessity for performing heavy farm work by motor tractors, and the automobile engineer has taken up the proposition with enthusiasm. Some of them say it is a simple problem, while others think it will take ten years to produce a satisfactory machine. Both would seem to be wrong, for they are apparently unaware of the great amount of work that has been done in this direction by makers of agricultural machinery. When the automobile engineer took up motor trucks, relying entirely on his previous experience, he thought it a simple problem, and with great confidence put his light pleasure car engine into a truck chassis. The result was a disastrous failure that has required many years to eliminate from the public mind. The truck was a special problem, requiring a careful study of entirely new and different conditions, and the farm tractor is in the same class. Steam tractors have been built for at least forty years, and many people have struggled with the problem of applying the internal combustion motor to the same work. It is to be hoped that those now undertaking the industry will make a careful study of past efforts and not burden the public with immature experiments.

Automobile Advertising Abroad.—We, in America, pride ourselves on our wideawake business methods, but there is much that we can learn from the old countries abroad. An example of this can be found in the advertising methods of the British automobile manufacturer. When business is booming our manufacturers put out a lot of hysterical publicity, but the minute sales begin to fall off they "economize" by cutting down their advertising. The British manufacturer, on the other hand, wisely appreciates that advertising is the foundation of his business, and he keeps it going steadily in hard times as well as good. It is many months since a pleasure car has been built in England, as all of the plants are occupied exclusively on war work; but there is no let up in their advertising. They are holding their *clientele* by keeping their names constantly before the public, and when the war is over they will be in a position to take up their business again where they left off, without a new campaign of publicity to remind the public of their existence and reëstablish their names. The patent medicine men knew this, for they learned from experience that if their advertisements stopped for one month it took three months of strenuous publicity to win back their sales. Anyone can sell cars in boom times, but it takes a wise man to maintain business when conditions are adverse.

How Rope Is Made

By Ernest Elva Weir

IN cataloging the uses of rope in his poem "The Ropewalk," Longfellow covered a good share of the changing phases in the drama of human life. And this is a reminder that many never give a thought to the seemingly unimportant industry of rope-, cord- and twine-making, or appreciate the difficulty of getting along without it in the everyday affairs of life.

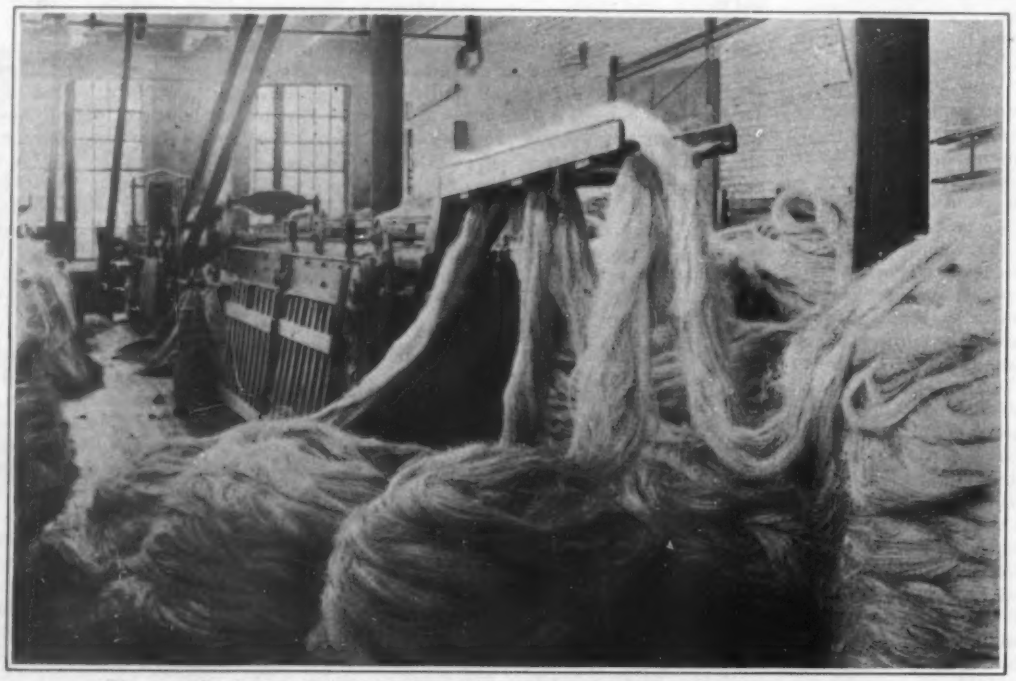
The rope industry is largely dependent upon imported material. Although Kentucky and California furnish a limited supply of American hemp, the Philippines, Russia, Italy and New Zealand provide most of the fiber consumed by American manufacturers. In commerce, the fiber takes its name from the country where grown, as Russian, Italian, American and Manila hemp, the latter being far more used than any other. With the exception of Manila, all these hemps are of bast fiber—that is, they are obtained from the bark of the plant. The hemp is cut, dried and then stacked in bundles. Later, it is again spread out and exposed to dew, frost and sun, a process that rots the gums binding the filaments. The dry inner woody part of the stem then falls off and leaves the fibrous strips in condition to be cleaned and baled for transportation to the various market centers.

Loading sisal leaves on a mule-train

Sisal, the sword-like leaves of the Mexican cactus, is another fiber employed in rope-making and ranks next in importance to Manila hemp. At cutting time, the natives, armed with knives, lop off the prickly growth and trim the thorns from the edges and ends. The leaves are tied in bundles and taken to the cleaning mill. Here the pulp is scraped from the fiber and, after a sun-drying, the latter is pressed into bales for shipping.

Although rope-making, reduced to its lowest terms, consists simply of a series of twisting processes, the machines used are exceptionally intricate. The wonder of modern machinery is nowhere more striking than in the preparation room of an up-to-date rope factory. Here the fiber is prepared for spinning by machines—breakers, spreaders and draw frames—that first comb away snarls, loose tow and dirt and then draw out the individual fibers into a soft fluffy, continuous body, which is called a sliver or roping.

Previous to 1838, ropemakers did all spinning by hand while walking backwards the length of a long narrow alleyway which became known as a ropewalk. Now, however, rope is made entirely by machine, the present-day type of spinner being known as the closed flyer. It draws the fiber from the sliver, carries it through a tube regulated to the size of the yarn desired, gives it a twist and feeds it onto large wooden revolving bobbins. Binder twine is always given a right-hand twist, yarns for certain kinds of rope a left-hand twist. In a modern spinning room, there are hundreds of these flyers running at a speed of fifteen hundred revolutions per minute.



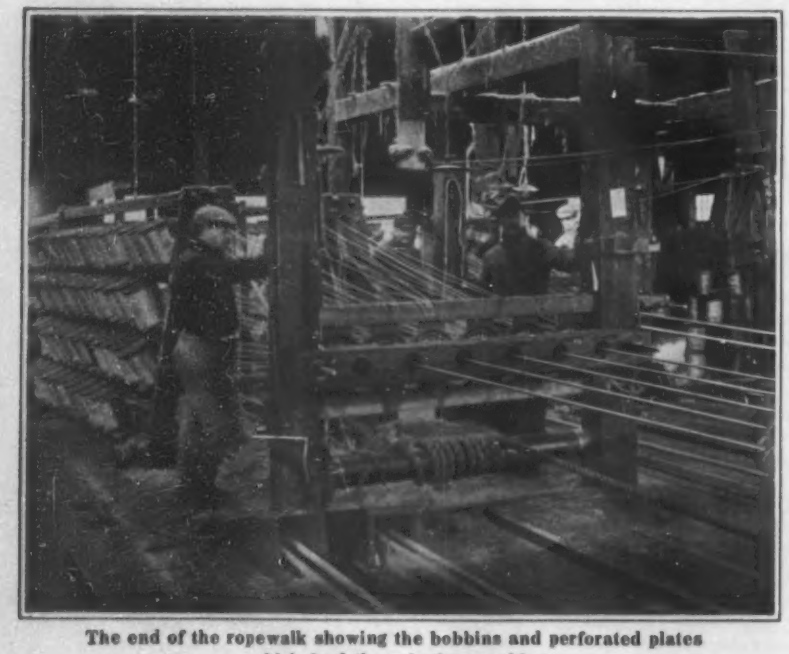
The spreader for separating the cleaned fiber and preparing it to be drawn out into yarn

The final processes in rope-making are called forming and laying. These names refer, respectively, to the twisting of the yarn into the strand and the uniting of the strands to make a rope. The second, of course, is merely a repetition, on a larger scale, of the first. These operations are performed by the modern ropewalk method for the very largest cables and tarred goods, and by the so-called factory method for smaller ropes, twines, etc.

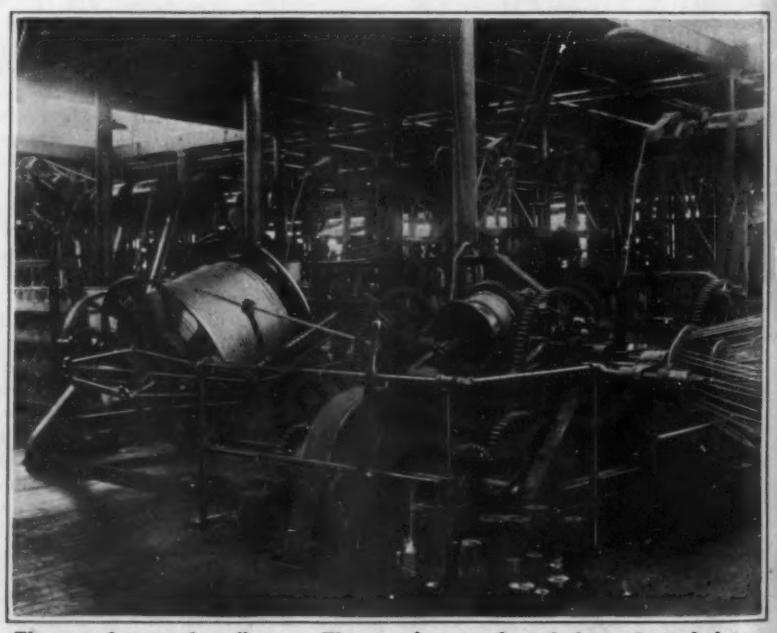
The persistence of the name indicates the character of the ropewalk of today. Instead of a man, a highly perfected machine, running upon a track, moves off down a long narrow space away from the bobbins that hold the slivers, twisting these together into rope strands as it goes, and trailing in its wake the ever-increasing length of these strands. Nowhere else in modern technology do we find to the same extent a machine which has replaced a man doing just what the man did in just the same way. Only, where the man under the old dispensation spun a single strand at each trip, the machine with its many fingers spins many.

Usually two tracks are laid out in parallel, one for forming and one for laying and each equipped with an endless bandrope to convey the power. From bobbins on frames at the head of the forming ground, the yarns for each strand pass first through a plate perforated in concentric circles to ensure the correct angle of delivery into a tube where the whole mass gets a certain amount of compression. Each group of yarns is attached to a separate spindle on the forming machine, a heavy carriage surmounted by the bandrope wheel into which are geared several spindles and a driving drum. The machine moves off, leaving in its wake the compactly twisted yarns. A man follows the machine, swings out the stakes placed at intervals along the walk and throws the strands over them. The forming machine then returns for another trip. The laying machines resemble the forming machines and perform the same kind of service for the strands.

The factory method takes much less space than the ropewalk but is only available for the smaller products. It is subdivided into the two-machine system in which the strands are formed on one type of machine and twisted into rope on another, and the one-machine system in which both operations are performed on a single machine. A complete set for the two-part method comprises two or more horizontal strand-forming machines, several bobbin frames and a vertical



The end of the ropewalk showing the bobbins and perforated plates which feed the spinning machine



The manufacture of small rope. The strands enter through the perforated plates at the right and the finished rope is wound upon the reel at the left

laying machine. The yarns are first drawn from the bobbins through perforated plates, the entire number being so distributed as to converge in layers and at the proper angle around one central yarn. They are next twisted in a tube by the revolution of a long carriage or flyer, from which they are guided in even layers to a winding reel. The revolution of this reel performs the office of taking up the rope as it is completed—the office which in bulkier work cannot be satisfactorily cared for otherwise than by the trailing principle of the ropewalk. For the laying process, the full reels are removed from the forming machine and are placed in the vertical flyers of the laying machine. These then twist the strands into rope and deliver the finished product to a belt-driven coiling reel.

The rope walk in operation. At the right, forming and laying machines advancing side by side. At the left, another walk showing completed strands and rope

Although the word "rope" has been used throughout, twines are made in the same way, the only difference being in the number and thickness of the strands.

The Microscope and Miladi's Hose

How the Simplest Kind of a Scientific Investigation Disposed of a Long-Standing Manufacturing Problem

THE SCIENTIFIC AMERICAN has had a good deal to say during the past few years about the application of science and scientific methods to the industries. The phrase usually impresses the business man without scientific experience as a trifle formidable, as implying extended physical and chemical research of a highly abstruse nature, and for which expensive equipment and expensive men are a prerequisite. In many instances the problems to be attacked do involve work of this sort; but in perhaps as many, results are to be obtained without the aid of any greatly specialized training, by the simple use of a few very simple scientific tools, and a modicum of common sense.

As we have had occasion to point out in other connections, one scientific tool which can be mastered to the point of effective use by any person of intelligence, and which once mastered has enormous possibilities of industrial application, is the microscope. Either alone or in conjunction with the camera, this instrument will often throw immediate light upon what appear to be the most perplexing questions. An instance of this which has just come to hand is of more than ordinary interest to us, because the manufacturer in the case confesses to having found in our pages the suggestion that photo-micrography would solve his problem.

This problem was one of hosiery fabrics. Of late years the desire for beauty has tended to outweigh the demand for utility in ladies' stockings. While the trend toward sheerness is more in the public eye now than formerly because of the prevailing styles in another fundamental article of feminine apparel, the leaning toward lighter and more gauzy hosiery fabrics dates back at least five years and has exercised an ever increasing influence upon the manufacturers. Germany first filled the demand with a diaphanous, heavily mercerized, chemically treated garment that had the desired appearance but would not survive a single washing. This was exported, especially to South America; and it is an actual fact that until the recent influx into that market of North American hosiery possessing both looks and quality the laundering of stockings was almost unheard of there.

Coincidently with the coming in of cobweb hose the problem of garter runs, or ladders, assumed importance. It may be pointed out that while half-hose are customarily finished with a rib knitting at the top, full length stockings carry a doubled-over hemmed top, with the idea of giving a double thickness of fabric in which to attach the garter. Formerly this double thickness extended down about two inches; and with medium and heavy weight goods this stood the strain well enough. But as stockings grew thinner and a neatly fitting ankle came to be more insisted upon by the consumers, the garters were pulled so tight that the excessive tension had a tendency to produce runs in the stocking. To offset these runs, which usually started at the garter clasp, the double hem portion was made wider and wider, until some hose had it for six or eight inches down the leg from the top. Even with this precaution, however, the runs continued to be a great cause of complaint, and special devices to stop them after they had started came into use. Some knitters put in a row of double loops about ten inches from the top. Others knit in a band of wool or worsted yarn which, being fluffy, stopped the run, at least in part. Still others inserted a ring of loops bearing a metallic substance, which was also partially effective.

None of these expedients, however, reached the heart of the matter; so, after trying several of them with indifferent success, a large firm of knitters in Rockford, Ill., applied the SCIENTIFIC AMERICAN's suggestion and called upon science and the microscope for aid. Stockings returned for replacement were carefully studied and it was found that practically all of the runs started at the top of the stocking and worked down. Some were caused by the sharp edges of imperfect or worn garters—a matter, of course, beyond the company's control. But it developed that the best part of the runs had started on the inside of the stocking, at the hem, and had then run up and over the top, and down on the outside of the garment. The weakness seemed to be right at the hem, just where the sewing machine needle had taken its stitches in the hemming process.

This needle, it must be borne in mind, pierces the fabric hundreds of times in one circuit. It was called for as the next step in the investigation; and it was at once evident that while it usually goes between the strands, it will not infrequently go through them. It is, moreover, twice as large in circumference as the coarsest yarn used; and a finer needle is not obtainable for the work. The hem was then put under the microscope, and the extent to which the fabric was weakened by the hemming operation became plain at once. One of our cuts shows, with a magnification of 6⅔ diameters (the original photo-micrograph was of ten diameters), the process of hemming just as the needle pierces the fabric. A darker yarn was used in the needle for the purpose of this test, so that the damage done might be more evident. This yarn shows at five points, which look like great holes in the fabric. Aside from this deceptive appearance, however, the actual piercing and twisting, with resultant weakening, are clearly evident.

Having gained this knowledge of the hem and its weakness, attention was turned to the garter pull and its effect. The microscope disclosed that a tightened garter exerts a pull in three directions—one vertically, and one from each corner at an angle of about fifteen degrees. It showed further that these strains are concentrated at the hem and spread out by it. The second cut shows the difficulty, the third the solution; both are reduced to about natural size, from photo-micrographs of some two diameters magnification. The narrowest

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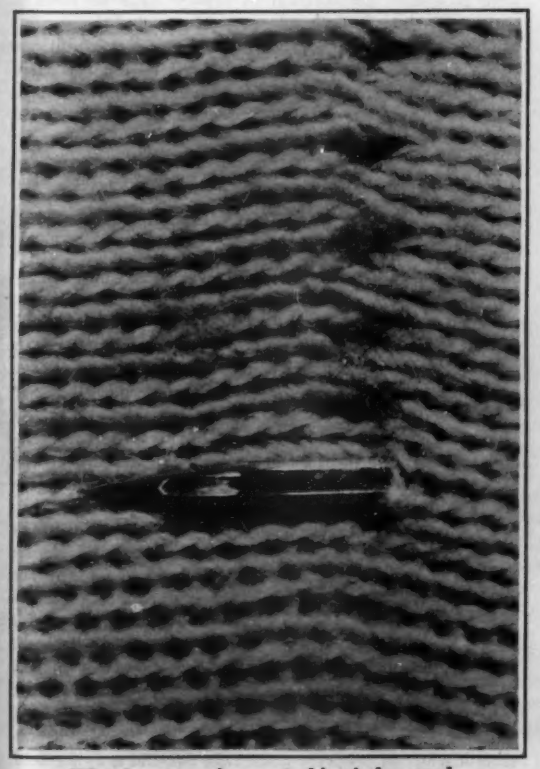
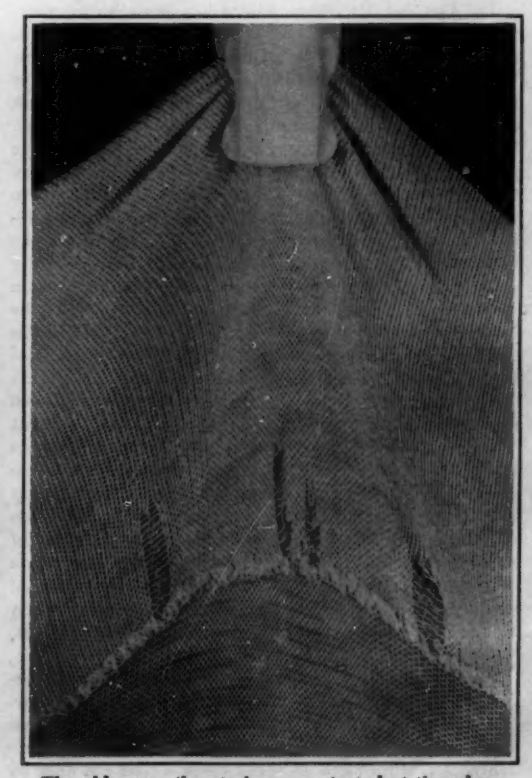


What happens when a stocking is hemmed; magnification 6⅔ diameters



The old way; the strain concentrated at the edge of a broad hem

The new way; a narrow hem with a broad facing to distribute the strain

"Preparing To Prepare"

Practical Work of the General Munitions Board of the Council of National Defense

By C. H. Claudy

EVERY war in which the United States has ever been engaged has, measured by present-day standards, been a little one. The volunteer system of getting men, and the catch-as-catch-can method of obtaining supplies always has sufficed for ultimate victory. Therefore, the "million-men-springing-armed-to-the-defense-of-the-Nation" idea has become as fundamental a part of American belief as that Washington was the greatest soldier, Lincoln the greatest president, Arnold the greatest traitor.

When a fundamental belief is shown to be an untruth, it hurts. So it has come with considerable shock to the United States, to learn that one must not only prepare in advance for modern war if it is to be successful, but that one must *prepare to prepare*.

Even yet it is none too well understood that preparation for military preparedness is as essential as was preparation for actual digging an essential if the canal was to be dug. For many months Congress, press and people alike demanded to know why dirt wasn't flying—now we all know it takes a live man to dig and men couldn't live until the Isthmus was prepared.

Today, if not Congress, at least many journals and many people are asking why we don't *do* something in this war, not realising that before we can prepare soldiers for war, we must prepare equipment for soldiers, only to be accomplished by a mobilization of industrial resource.

Such has been the work of the General Munitions Board of the Council of National Defense—a *preparation*, looking to the speedy accomplishment of National preparedness.

In times of peace it is easy enough to buy a hundred guns, or a thousand rounds of ammunition, or a gross of field glasses, or trench periscopes, or a portable wireless, or an armored car. But when the figures are multiplied sufficiently to equip an army of a million men, and when that equipment must be made in a limited time, chaos would be the result under the old system of open market buying, in which the government appeared as a customer ready to be stuck for the highest price, and the manufacturer as a free lance, who bid as he pleased, what he pleased, when he pleased.

To the man in the street "munitions" means ammunitions and shells. To the General Munitions Board it means almost anything from a cantonment to a tin cup. Guns, yes, rifles, yes, small arms, yes, ammunition, yes; but also a thousand other things equally essential, if not so spectacular.

So the General Munitions Board, Frank A. Scott (Vice-president of Warner and Swasey Co.), Chairman, which meets daily at the Council of National Defense, has many sub-committees, doing work of which the general public hears little and knows less. Because it has seventeen members drawn from Army and Navy, one from each of the most important bureaus, it is in the closest possible touch with what the fighting arms want and need. And because it has, on its sub-committees, civilian experts who are the pick of the country from their special work, it is able to supply the necessary information and advice which will most swiftly and most satisfactorily fill those needs.

The sub-committees, and their chairmen, are: Army and Navy Projectiles, W. H. Vandervoort of Root and Vandervoort Engineering Co.; Army and Navy Artillery, S. M. Vauclain of Baldwin Locomotive Works; Fuses and Detonators, E. A. Deeds of Dayton Engineering Laboratories; Gages, Jigs and Dies, F. C. Pratt of the General Electric Co.; Optical Instruments, Frank A. Scott of Warner and Swasey (also Chairman of the General Munitions Board); Small Arms and Ammunition, J. E. Otterson of the Winchester Arms Co.; Machine Guns, B. M. W. Hanson of Pratt and Whitney; Priority, General Aleshire of the U. S. Army; Armored Cars, Colonel Rice of the Bureau of Ordnance, U. S. A.; Pressed Steel, B. P. Bole of Hydraulic Pressed Steel Co.; Army Vehicles, Wm. Butterworth of Deere and Co.; Storage Facilities, Morris L. Cooke, Consulting Engineer; Legal Matters, R. J. Bulkley of Bulkley, Hauxhurts, Saeger and Jamison; Accountancy, E. L. Suffern, and Emergency Construction and Contracts, W. A. Starrett of Starrett and Van Vleck.

The Committee on Raw Materials, Mr. Bernard Baruch, Chairman, and the sub-committees of Lumber and Cement, and the Committee on Supplies, Mr. Julius Rosenwald, Chairman, in addition to their own splendid work, have coöperated most effectively with the General Munitions Board.

It is obvious that a detailed statement of the activities of all these committees would mean a library, not an article. No such attempt will be made. But, put as nearly in a paragraph as possible (and it is packing considerable meat in a very small shell!), the general work of the General Munitions Board has been to act as a clearing house for the requirements of Army and Navy; to find their needs, to develop sources of supply to fill those needs, to suggest methods to secure efficiency and speed in satisfying the needs together with economy of purchase, to recommend means to eliminate delay in contracts and payments, advise financial assistance where factory expansion in a hurry was and is a necessity, and to aid in housing not only the to-be-created Army (cantonment problem) but help the Quartermaster Corps to house the supplies and stores as they are made, bought and delivered.

All these activities have been carried on without obligating the Government in any way by contract or orders, and no Government money has been expended by the General Munitions Board, except such funds as were voted expressly by Congress, for carrying on the executive work of the Council of National Defense.

Every one connected with this voluntary civilian work has realized from the beginning that it would be undesirable, improper and illegal in any way to take away the power of obligating Government money from the proper Government officers charged by law with that responsibility. The functions of the Board are primarily to report facts to Government officials in order to assist them in wisely expending the public money. In fact purchasing powers were expressly denied the General Munitions Board by the Council of National Defense in the resolution creating the Board.

Ask the man in the street what the first thing needed by an army of a million men may be.

"Rifles" he answers.

So the rifle problem was one of the first to be tackled by the Board.

Obviously, the first thing to do was take advantage of the manufacturing start given us by our Allies, when they were simply fighting nations buying of a neutral nation. But the Allies had been buying rifles (Lee-Enfield) which were .303 caliber. All United States army rifles are .30 caliber. To use .303 rifles meant two standards, two kinds of ammunition and forty varieties of trouble. To use .30 caliber meant, in many cases, almost rebuilding rifle-making machinery.

But it was done. Through the General Munitions Board, the three great rifle plants of this country not operated by the Government, remolded their factories, made the changes, met the Government half-way and a little more in the matter of time and payment—and when the million men are ready to shoulder guns with which to fight, the million guns will be ready for them to shoulder. In other words, one million new rifles will be delivered by April 1st, 1918, in addition to what we now have.

Ask any officer visiting this country from abroad what is the most important thing in the modern battle, and he answers, most probably, "Artillery and plenty of ammunition for it."

The General Munitions Board has been busy—very, very busy, developing an adequate supply of guns. And the results are both an inspiration and a comfort. Work is now in progress in many factories which never previously even saw a field gun, looking to the turning out of hundreds of thousands of pounds of gun forgings. While some forging deliveries will begin this fall, the great bulk will not commence to be ready for delivery much before January 1st. But by July 1st, 1918, there will have been over 25,000,000 pounds of gun forgings delivered beyond our present capacities, together with the necessary caissons, timbers, and materials, and by January 1st, 1919, as much more. As the average gun includes something like 3,000 pounds of forgings, the available supply developed by the General Munitions Board in conjunction with the Ordnance Departments of the Army and Navy is seen to be tremendous.

To line these factories up for such production has been exacting work—"Preparing to prepare" work, without which our drafted army would be helpless. It has meant correspondence without end, diplomatic work to get factory owners to see the real need the Government had of them, inspection of factories, plans for alteration of machinery, satisfactory arrangments for purchase of new machinery and expanding factories, standardization of contract rates (a very vital matter) and methods of payment and a thousand adjustments by the Priority Committee which advises in regard to who gets what, when every one wants all there is!

Ammunition? Given the raw material it is no problem at all to get shells. The Allies during their near-three years' buying here have developed for us an immense shell-making industry. But raw materials have presented a real problem, in many cases solved not only by the work of the raw materials' committee, but by the patriotic collaboration of manufacturers.

Give an army rifles and guns and ammunition, and it could undoubtedly fight. But meanwhile it must be fed and clothed and housed.

Feeding the Army is not like clothing them. A man eats just so much, whether as a civilian or a soldier. A million soldiers to be fed means a million less civilians to be fed. So that the prospect is not so disturbing—economically considered—as clothing them. But—a million uniforms, a million pair of blankets, a million cots, belts, hats—millions of shoes, socks, underwear and then the tremendous quantities of things needed to *make* these things, and all wanted right away, *quick*—that was a real problem.

The Committee on Supplies of the Advisory Commission, Mr. Julius Rosenwald, Chairman, has done it. Moreover, it has been done at a great saving of money to the Government, over any possible result under the old plans for Army buying, now, let it be hoped, gone forever. Formerly, if Uncle Sam wanted a million blankets, he asked for them, took the lowest bids, and bought—as best he could. Today, the Supply Committee of the General Munitions Board first arranged with wool buyers and manufacturers. It got their patriotic coöperation and—*wool at a fair price*. Then it went to the blanket manufacturers, for bids, not on *blankets*, but on *making* blankets—wool supplied! Result, plenty of blankets at a reasonable, economical, satisfactory price.

The Committee has done the same thing in shoes, and between four and five million pairs have been purchased in this way, without, on the one hand, mulcting the Government (as has been done sometimes in the past, *vide* the Embalmed Beef of sainted Spanish War memory) and without undue disturbance of commercial life on the other. Civilian requirements must be taken care of, war or no war. It is easy enough to say "If they haven't food or clothes or shoes enough—these brave lads of ours—let us stop everything, until they are supplied." But it won't work. The people who support the soldier, the artisans who make his rifle, the tailors who make his clothes—and their wives and children and dependents—must be fed, shod, blanketed, just the same, or the soldier as well as the nation, suffers.

All of this sounds very simple. But in the purchases of supplies, by methods and from places recommended by the Supplies Committees of the General Munitions Board, the Government has not only saved millions and millions in cash outlay, but untold other millions in the lack of economic disturbance which has resulted from these huge purchases.

As every one knows, it will require sixteen huge cantonments, approximately able to hold 30,000 men each, to roof the new Army when it is drafted. The cantonments are to be built in ninety days. They will cost in the neighborhood of $80,000,000.

If you, who read this, were suddenly confronted with the job of picking out sixteen contractors, who, together, were to spend $80,000,000 in ninety days to erect a bigger city than Buffalo, *where would you find the men?*

That was one of the problems the General Munitions Board had to solve. And they solved it—oh yes, they solved it, and quickly. At the request of the officer in charge of cantonments, they picked sixteen firms to recommend to the Quartermaster Corps, picked them from the biggest and most reputable contractors in the country, such firms being chosen or rejected as the Quartermaster's Department believed proper. They picked them out by a process of elimination, careful investigation and geographic location—men who have handled big work in the past, men with financial resources sufficient to float over any Government slowness of payment necessitated by red tape, men who were not only willing but anxious to take the job on the Government's own terms of a percentage of cost as their profit, and no profit to be more than a quarter of a million.

The sixteen men selected by the Quartermaster Department will spend, in three months, more than one-and-a-half times the largest yearly expenditure of the Panama canal. They *had* to be the best men in the country for the job, or the job couldn't be done.

Through the system of interlocking memberships in the various committees of the Council of National Defense, a great deal of lost motion is eliminated in making the work of one body useful to that of another. Thus, when the Aircraft Production Board wants contractors for Army aero fields and their huge buildings, it does not have to duplicate the work already done—it merely turns to that work of the General Munitions Board recommending certain contractors for cantonments, and finds all the information there is about every possible contractor who can properly undertake to build a flying field.

Without making any comparison or picking one

(Concluded on page 17)

Doing Our Bit—I.

The Immediate Task for America

NEVER before has a war more surely demonstrated the value of striking quickly than has the present cataclysm. Because England was not ready to place a large army in the field with France, their common enemy devoured miles a day of a country from which it is now being blasted by yards a week.

But because England put every man she had into France in the first three days of the war, because they fought to the utmost that was in them from the very start, the flood was dammed at the Marne, and England was saved at Ypres.

That this country is not ready for war we all know. That we are entering the struggle at a most critical time few seem to realize. The balance is swaying and every ounce we can throw into it now may save tons later on.

Our mission is simple and self evident; to help our Allies where they most need help. Our assistance will be the three great M's: Money, Munitions and Men. The Liberty Loan was a success; munitions factories are mushrooming up all over the country, and ten million men have registered. Yet we must face the grim fact that it is not the strength we have that counts but the strength we use.

We have loaned a stupendous amount of money to our Allies—to be spent in this country. We have increased tremendously the output of farms and factories —in this country. We are raising a large army—in this country. And the battle front is in France, with three thousand miles of wet sea across which every man and every ton must be conveyed. The success of our efforts is not measured by what we create in America but by what we deliver in France, and the war may depend not on what we deliver in 1918, but on what we deliver this month!

To cross the ocean requires ships, large, seaworthy ships. There is a certain number of ships in the country today and in no way can we immediately increase this number; for the present this is the entire amount of our transportation resources.

We are making every possible effort to increase our building capacity and to speed up our shipyards, and all such steps are excellent, but the stubborn fact remains that *today* is the time that we can best help to win the war. The prosaic Germans are so lacking in imagination that one or two extra ships carrying ammunition to France would probably produce a greater impression than would our rosy plan for a "bridge of boats" next year or the year after. Build for the future by all means, but work our present tonnage to the limit today!

Having at our hand the total number of sea-going ships, we find that we cannot employ them all directly on war service. Many trade routes are so important that to cut off trade along them would defeat the very ends we sought, because without the cargoes these ships carry we could not furnish ourselves and our Allies with munitions.

This is so well recognized that the Government itself enters here the shipping business. Hemp, for instance, is now being freighted to this country in Navy colliers, and nitrate rides up from Iquique in Army transports, so vital is it for war purposes.

With the maximum number of ships available, the next step is to see that the maximum amount of cargo is delivered abroad in a given time. The first essential is to see that it is delivered at all. This being the solution of the "submarine problem," cannot be attained in perfection, but it can be much more closely approximated than at present. Navies are conducting an offensive campaign against submarines: it is just as important that the merchant marine should develop a defensive one.

The elements of defense against the submarine are: a look-out to see it, maneuvering ability to elude it, speed to escape it and a gun to keep it below water.

Of the greatest and least realized import is the look-out. A vigilant man in the crow's nest should in nearly every case see a submarine as soon as the latter can make out the ship. A periscope is a hard thing to see, but even harder to see through. Except for cases of luck, where a U-boat pops up from below and finds herself close to a merchantman, nothing but rank negligence allows an attacker to approach closer than two thousand yards unnoticed.

Once the submarine has been sighted, an alert watch officer, fully cognizant of the limitations of the German U-boats and of their torpedoes, will handle his ship to best avoid attack. The situation may call for turning towards the submarine or for turning away from it: the correct decision must be instantly reached and acted upon. Here again the trained look-out is invaluable in noting and reporting the distance and actions of the threatening craft.

Britain's greatest discovery of the war was that a gun on a merchantman increased its "expectation of life" 300 per cent. This has already been confirmed by the vessels flying our flag. Still the great virtue of a gun lies in the fact that it forces the enemy to operate submerged, where his speed is twelve knots, his radius low, and his only weapon the torpedo, instead of on the surface, where he has an unlimited eighteen knots at command and the accurate quick-firer or the simple bomb for destructive purposes.

A very slow ship might be torpedoed from astern by a submerged vessel, but given that the enemy is seen in time to turn away from it; given a gun to keep it below surface; given a speed equal to the submarine's in such conditions, and the ship is safe. The German torpedo is a short-range, "cold-shot" weapon with no curved-fire device. That is, it is aimed by pointing the submarine to hit a ship; the submarine must point ahead of its prey, and the amount in most cases must be guessed at. The faster the ship, the greater the "offset" and the greater the chance of error. Excepting the "Lusitania," which was probably ambushed, very few ships have been sunk while steaming at better than fifteen knots.

By running vessels across the ocean at their highest speed we accomplish two important results; first, we increase the chances of the vessel getting through the danger zone; and second, we increase the amount of cargo she carries. Evidently a ship running to Europe and back at sixteen knots, actually carries twice as much cargo as she would if she only steamed eight. It is not possible to increase the machinery installation of our cargo ships in such manner as to double their speed, but it is perfectly possible to get the utmost out of their present equipment.

To work a steam plant at its maximum the boilers must be free from scale, the fuel of the best and the firing expert and systematic. The engine clearances must be correct, rings and glands tight, and steam losses eliminated. The use of the higher grades of coal, such as are Navy standards, would alone probably create a marked improvement.

Increasing the ship's speed is only part of the work of increasing the speed with which she makes trips. Equally vital is it to expedite her loading and unloading, and above all is it essential to combat the added wear and tear which the higher speeds tend to aggravate.

High grade coal, high grade material, spare parts to hand, ample repair and overhaul facilities in port—these are the first material needs of an efficient supply train.

From the standpoint of personnel, we must have trained deck officers, fully acquainted with the conditions of the problem they are to meet; efficient engineer officers, who can coax every possible revolution from the engines, firemen who will make every pound of coal count, and enough of them to make every trip a "builder's run."

This improvement in material and in personnel we have needed since the outbreak of war, in order to help bear our share of the struggle. From now on we have more than ever a direct stake in the merchant marine.

By sending men, our own soldiers, across the ocean, we commit ourselves to the absolute necessity of maintaining their supply chain intact, come what may. The delay of a day in the arrival of an ammunition ship may mean disgrace or disaster to our troops. Ships must swing back and forth across the ocean like pendulums, and a longshoreman strike or a delay in finding a crew for a vessel will terribly jar the intricate war mechanism which is erected upon punctuality, and whose every joint must dovetail perfectly.

For every soldier that we land in France, twenty-five tons of shipping must plow back and forth at a steady ten knots to supply his needs alone. For twenty-five thousand men this means one hundred ships—a number that we would be hard pressed to find. And this means curtailment of the vital supplies to our Allies.

Now, could the average speed of this fleet be raised to eleven knots and could the time in port be reduced 10 per cent, we could release for other service some sixty thousand tons of shipping. In other words we could create immediately that amount of extra tonnage and add it to our merchant marine, not in 1918, but today. And today may be the day, the real "Day," the day the balance will swing. Are we to help it?

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

Grinding Lenses

To the Editor of the SCIENTIFIC AMERICAN:

I have read the letter in the SCIENTIFIC AMERICAN of May 26th by T. J. Johnson that states to send 75 cents, to the Smithsonian Institution, to get a copy of the treatise on glass specula by Ritchey and the late Dr. Draper.

Mr. Johnson writes that Dr. Draper was the originator of the methods of grinding, polishing, testing, etc., of glass specula. He is far from the truth. Dr. Draper does not claim to be the originator of these discoveries. If Mr. Johnson has read Dr. Draper's book, he has read that Dr. Draper says that science is largely indebted to Professor Foucault; he gives the graphs, the methods of getting the desired curves, the methods of testing the spherical surface, of parabolizing the finished spherical surface, of silvering, etc., developed by Professor Foucault. One who wants the works of M. Foucault, may write to the Observatory of Paris.

Dr. Draper was like any expert mechanician; he had his individual ways to perform a work, which depended upon the discoveries of a first-class scientist, in this case M. Foucault.

NAPOLÉON CARREAU.

Wichita, Kan.

Nets for the North Sea

To the Editor of the SCIENTIFIC AMERICAN:

I have been reading the different plans, suggested by your readers, of combating the U-boat.

One of the most feasible, seems to me, is that of Mr. Covington, regarding the netting of the North Sea.

I would like to make this suggestion, that the nets be composed of 10-foot length of chain, with a snap hook in each end, and 3-inch links.

These nets would be assembled on board ship and would form a continuous net from shore to shore.

About 3,760,000 lengths of chain would be required to form a net 250 miles long by 150 feet deep.

The mines should also snap in between the mesh, to keep them in position. Damaged links would be easily replaced with new, in very short time.

Assembling the nets on ship board, removes the chief objection to netting, namely the bulk. These chains would also be of great service in the engineer corps, for the forming of barriers, bridges, etc.

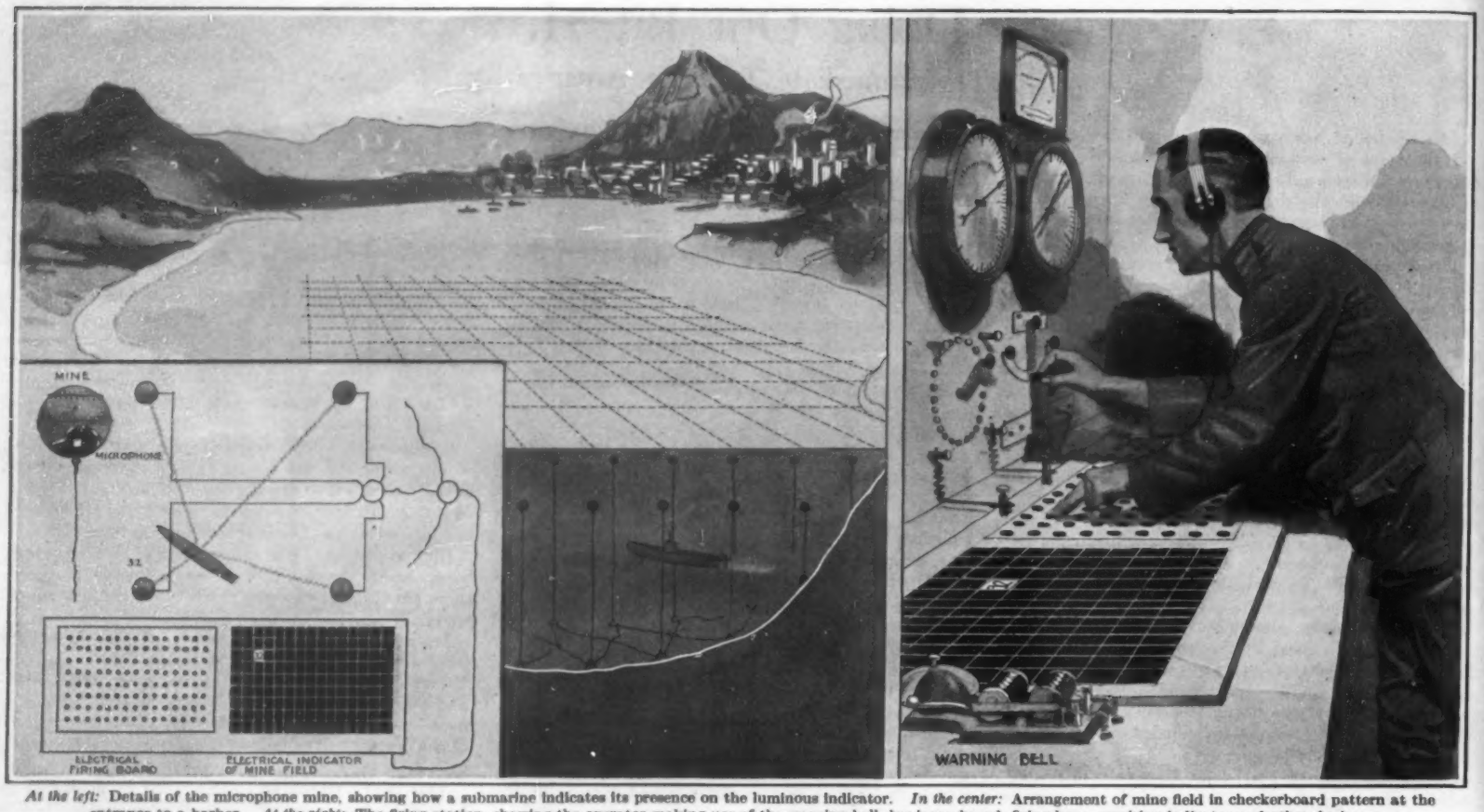
I am sending this to you, in hopes that you might place this suggestion where it would do the most good.

J. F. FOWLER.

Roslindale, Mass.

The Current Supplement

THE current SCIENTIFIC AMERICAN SUPPLEMENT No. 2166 for July 7th offers much matter of general interest. The leading article on *The Resources of the Russian Empire* contains a great amount of valuable information that is of economic importance to the American people. *The Military Rifle* tells in an untechnical way of the many intricate processes in the making of a rifle barrel, and of the remarkable skill necessary in their performance. It is illustrated by several photographs taken in one of our Government armories. *The History of Individual Armor* gives a brief history of the devices that were employed in ancient times for the protection of the soldier, and shows in an excellent illustration how many of these ancient devices have been revived and applied in the great war in Europe. *Galvanizing and Tinning Wire* gives a description of processes used in Europe, as recently published in a German technical paper. *An Era of New Food Resources* calls attention to the work that is being done in developing new food supplies, many of them of an unusual character. Four striking photographs suggest what we may come to if our resources are not rigidly conserved. *Military Motor Truck Design* is a most valuable paper that tells the results of experience and experiments in army transportation on the Mexican border during the recent maneuvers of our forces in that region. *Trench Building Animals* is a very readable story of the engineering feats of various animals, birds and insects that construct their habitations underground, and is accompanied by numerous illustrations. *The Propagation of Electric Waves* deals with problems relating to the transmission of wireless impulses, and is illustrated by several diagrams. *An Enlarged Electron of Practical Size* discusses an interesting problem of physical chemistry. A number of other articles are included in this issue.



At the left: Details of the microphone mine, showing how a submarine indicates its presence on the luminous indicator. *In the center:* Arrangement of mine field in checkerboard pattern at the entrance to a harbor. *At the right:* The firing station, showing the operator making use of the warning bell, luminous board, firing keys, precision indicator and other devices.

Eavesdropping mines which detect the presence of submarines and surface craft, and combine the advantages of electrically-fired and contact types of mine

The Submarine Problem—VI.

Principles, Promising and Otherwise, Which May Be Applied in Detecting the U-Boats

ALL naval men are agreed that the best method of procedure against the submarine menace is to attack the U-boats at their bases; in other words, the ocean is expansive, and once a German submarine escapes to the open sea the area over which the hunt must be conducted is such that the chances of capturing or destroying it are few. Indeed, it is the old case of an ounce of prevention being worth a pound of cure; but in this particular instance the proportion is somewhat altered—the ounce of prevention is readily worth a ton of cure. However, just so long as the submarines are permitted to roam the high seas the submarine problem resolves itself into a matter of detecting and capturing or destroying the U-boats; all of which stands for the ton of cure.

Of paramount importance is the detection of the German U-boats, for once their presence is known they are robbed of their initial and greatest advantage—invisibility. Naval men have told us time and again that given the location of a U-boat, the task of capturing or destroying it becomes almost automatic, or at least simple and practically certain. So the subject of detection is an important one and should receive the immediate and best attention of all inventors working on the submarine problem. To this end there has been collected a number of suggestions and principles which, after careful study, have either been held as having special promise or as entirely misleading with regard to the detection of U-boats, and this collection forms the basis of the present article.

THE detection of the submarine is the subject of the present article, the sixth of a series on the submarine problem appearing in this journal. In view of the efforts of thousands of inventive Americans to help solve the submarine problem, the author of this article has endeavored to outline such principles as appear to lend themselves favorably to the problem in hand, as well as those principles which at the outset appear to be barren of result. For obvious reasons no attempt has been made to describe actual systems which may now be in use, the purpose of the article being more in the nature of a guide to those at work on the problem of the day.—EDITOR.

Seeing Under Water in Fancy and in Fact

Prominent among the suggestions offered by inventors is that of using some form of optical instrument, such as an inverted periscope, for seeing under water. When it comes to seeing any appreciable distance, say even a few hundred feet, the inverted periscope and other similar devices are practically valueless. Mr. Harold A. C. Sintsenich, a cinematographer who has exposed thousands of feet of film at the bottom of the sea by means of the well-known Williamson tube, states that under the best conditions one cannot see more than 100 feet, and even then the objects are hazy masses devoid of detail. Beyond that distance—at a depth of 30 feet or more—everything blends into a dark green background. Now the point to bear in mind is that the Williamson apparatus permits of direct vision through a two-inch thickness of optically perfect glass, and there is a minimum of light absorption; and if 100 feet appears to be the extreme range of vision under ideal conditions, surely the distance would be considerably shorter when using any type of periscope. As the depth increases the vision rapidly decreases, for sunlight penetrates the water only in a very limited way. Even with the aid of powerful lights it is impossible to increase the range of vision, since there is no better illuminant than sunlight to begin with.

The Fallacy of the Submerged Searchlight

The use of submarine searchlights has been suggested for the purpose of detecting the U-boats, one plan being to employ a red beam of light which, according to the inventor, could be seen stretching out from the hull of the ship to a distance of several miles by an observer in the crow's nest. The red beam, it is claimed, would form a more striking contrast with the green water than a white one, hence it could be seen during daylight. By means of a remote electrical control the observer could play the projector around, watching all the while the thin pencil of light some two miles in length. Should a submarine be lurking in the vicinity of the ship, the beam of light would come in contact with it, and obviously the pencil of light would be interrupted at that point. The observer, noting that the pencil of light did not extend its normal distance, would immediately know that some object was interposed in the beam at that point. With the angles of the sighting instrument and the projector known, and working with a base line—the distance between the sighting instrument and the projector—of known length, the exact distance of the submarine from the ship could be accurately determined and communicated to the gun crew.

Unfortunately, however, it is quite impossible to penetrate water for any great distance with light of any kind, daylight included. It may be true that red light would serve to better advantage because of the contrast with the green mass of water; still, the fact remains that its penetrative power would be less than that of white light. Experiments performed with a standard 30-inch projector indicate that 200 feet is the greatest distance that can be penetrated by a highly concentrated beam, and needless to say this distance is totally inadequate.

Expecting the Impossible from Magnetism

The electro-magnet has been the center of much interest in connection with the submarine detecting problem, and numerous have been the suggestions to employ magnetism in some form or another. Generally, the scheme is to lower electro-magnets into the water and tow them along, with the object of having them attracted to the steel sides of any submarine they may encounter—a sort of magnetic fishing, as it were. Once the electro-magnets firmly hold on the submarine there are several procedures, depending upon the ideas of the individual inventor. Some advocate sliding a contact bomb down the wire cable connected to the electro-magnet, while others suggest lifting the submarine out of the water, capturing it intact and making its crew prisoners!

If persons interested in the electro-magnetic detector would spend a few minutes of their time experimenting with a permanent magnet, or, better still, an electro-magnet, they would soon learn the fallacy of this method. To begin with, magnetic lines of force are curved, starting at one pole of the magnet and terminating at the other. For this reason magnetic force is very localized; as an example of this, suppose an electro-magnet will lift ten pounds readily, it is bizarre indeed that the same magnet will not attract a small nail a few feet away. But such is the fact.

In consequence it becomes evident that fishing for submarines by means of electro-magnets is not a remunerative method, for the ocean is big and in order to detect the U-boat it is absolutely necessary to have the electro-magnet come into *actual contact* with the steel mass. As for the holding power of the magnet when once in contact with the steel plates of the underwater prey, there is no doubt, since windings of any desired strength can readily be used; but the suggestion on the whole is so typical of hunting a needle in a haystack that its application seems precluded from the very start.

If a magnet did possess the power of attracting large bodies at a distance, as most inventors evidently take for granted, this method would hold much promise. But unfortunately this is not the case, and we are unable to change the phenomenon of magnetism.

A variation of the electro-magnetic principle is the suggested use of a sensitive compass to detect the

presence of a great mass of steel, such as a submarine. However, it must be taken for granted that the device is to be employed aboard a wooden ship, which eliminates it from consideration where a steel vessel is concerned, thereby limiting its application to wooden cargo boats and small craft. While it is true that a compass needle is quite sensitive, it is doubtful if it would prove of much value in detecting a submarine hull a short distance away, even under ideal conditions.

Can Electrical Resistance and Induction Effects Be Enlisted?

Water, especially salt water, is a pretty fair conductor of electricity. Taking advantage of this fact at least one inventor has suggested making use of electrodes arranged in the form of buoys or even using electrically-fired mines themselves, and measuring the resistance of the water between pairs by means of sensitive electrical instruments. Under normal conditions the resistance would not vary appreciably; but once a submarine passed between the electrodes its huge bulk, several times that of the electrodes, would materially affect the resistance of the circuit, allowing more current to flow through and indicating a greater deflection on the galvanometers or other measuring instruments. All of which sounds most promising on paper.

However, salt water is such an excellent conductor of electricity that electrical engineers scoff at the practicability of this idea. They point out that the drop in resistance brought about by the passage of a submarine would be very small, even when the electrodes or mines were placed close together; and if the electrical instruments were made delicate enough to detect this slight drop in resistance, the slightest irregularity in the positioning of the electrodes and the thinnest layer of oxide or dust on the switch contacts would give misleading indications. In other words, the drop in resistance which is depended upon to detect submarines is so slight that the apparatus is far too sensitive for practical use. It is strictly in the laboratory class, if at all feasible. Even if we were to admit its practicability, it is obvious that this suggestion is intended primarily for harbor defense works and is hardly applicable to hunting the U-boat on the high seas.

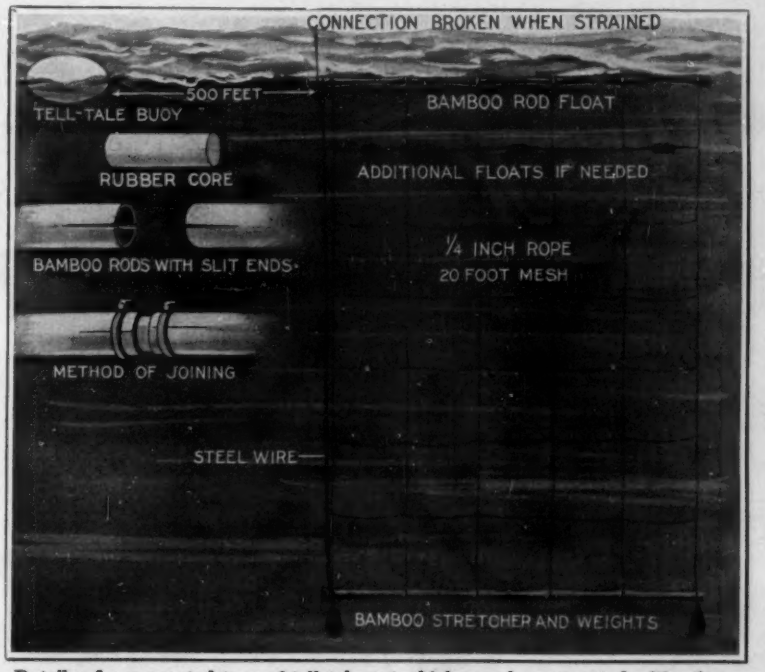
Probably borrowing a leaf from the method employed in France for discovering unexploded shells on erstwhile battlefields about to be plowed, the Hughes induction balance has been suggested as a means of locating submarines. This delicate electrical instrument, as is well-known, detects the presence of metal bodies at a considerable distance—in the laboratory, but in connection with the submarine problem it is doubtful if it could be made sufficiently sensitive to detect U-boats at an appreciable distance. Indeed, the main difficulty with this and many other suggestions is that the U-commander very unobligingly keeps his craft at a distance far beyond that at which it may be detected. Still, the Hughes induction balance principle may not be altogether hopeless if developed on an ambitious scale.

Tell-Tale Nets Which Tag the Unsuspecting U-boat

Simple to make, inexpensive and evidently practical, the tell-tale net suggested by Mr. Lewis B. Shader of Union Hill, N. J., presents an interesting example of what can be done in the way of mechanical contrivances. As will be noted in the two accompanying illustrations depicting his tell-tale net and how it is used, he proposes using a net of ¼-inch twine and 20-foot mesh, supported from a bamboo rod float and provided at the bottom with a bamboo stretcher and weights. At the left of the net is a steel wire or cable, which, starting from the end of the bamboo stretcher, passes up along the side of the net, through a detachable ring at the end of the bamboo float, and then pays out several hundred feet until it reaches a tell-tale buoy. The net is made on the unit principle; that is to say, a number of them may be combined by means of the simple flexible connection shown in the detail drawing. The twine or rope may be colored green, so as to be indiscernible at even a small distance away, and additional floats may be provided as shown, if necessary.

According to Mr. Shader these nets can be manufactured in very large quantities, because of their simplicity and low cost, and their weight and bulk is such that they can be carried in large numbers by torpedo-boat destroyers and submarine chasers. The nets can be scattered about promiscuously on the high seas, particularly where submarines are known to be active.

The action of the tell-tale net is this: The submarine, running submerged, runs into the net and becomes ensnarled in it without the commander's being aware of the fact, for the reason that the twine is light and produces no sound, and in no way affects the motion of the U-boat. However, as the underwater craft proceeds with the net it trails behind it the surface buoy, which effectually tags it so that nearby surface craft can detect its presence and follow it. While this feature alone is sufficient to make the tell-tale net effective, Mr. Shader suggests using a trolley bomb which can be applied to the end of the steel wire or cable in the manner shown in the second illustration. For this purpose the surface craft speeds up to the buoy, which is picked up, and by pulling slightly on the cable causes the connection between it and the bamboo rod float to be broken. Thus the steel wire goes directly to the bamboo stretcher which, together with the net, is wrapped about the submarine, and when a contact bomb is placed on the wire it should be possible with some maneuvering to slide it down against the side of the U-boat with disastrous effects to the latter.



Details of a suggested type of tell-tale net which may be connected with other similar units to form large nets

All in all, this suggestion has much to commend it, and might well be used as a model by others working on the submarine problem.

Letting the Ears Do the Work of the Eyes

If the eyes are of little value under water the same is fortunately not true of the ears; for water is a most excellent conductor of sound and lends itself nicely to sound detecting systems. The fact that there are no so-called zones of silence in the water and that it is a homogeneous medium permits of the use of sound-detecting system with every advantage at the outset.

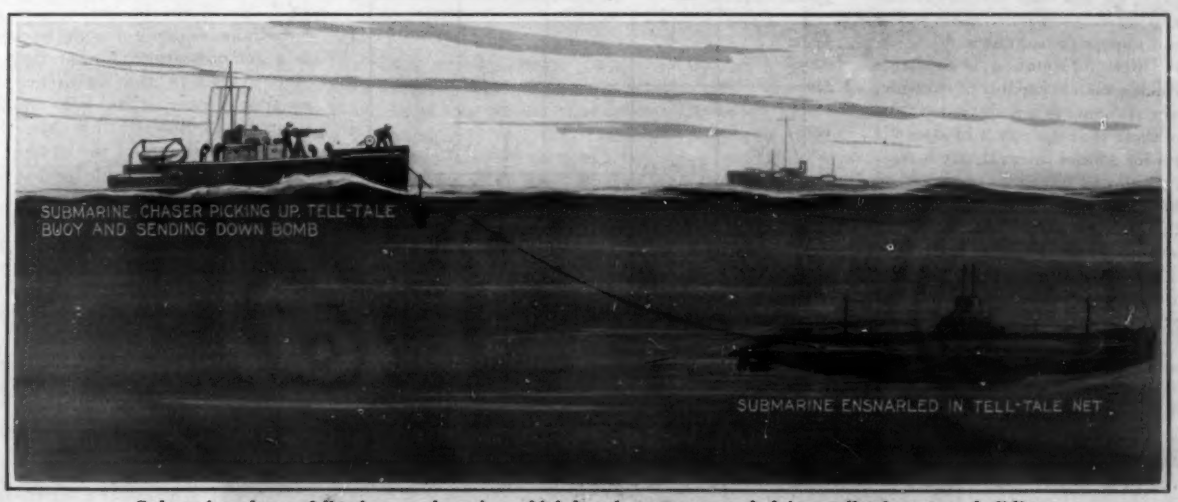
It is understood that much is being done in the way of employing megaphones for the detection of submarines, and some of these systems have already reached a remarkable state of development, permitting not only the presence of a U-boat to be detected, but also its exact position so that the range can be given to a gun crew. It is well to add here that the original microphone system employed by the Entente powers some time ago operated quite satisfactorily, according to reports, until the Germans saw fit to mount their motors on sound-absorbing bases, thus making their submarines practically silent and foiling the megaphone ears of the British and French land stations. However, the latest systems of microphonic detection do not rely upon the submarine's hum, hence it is of no consequence whether the German craft are noiseless or noisy, running at top speed or resting on the bottom.

A most promising system of microphonic detection has been developed by a New York inventor, and although the general details were disclosed to the editor of the SCIENTIFIC AMERICAN and a drawing prepared showing the main parts of the apparatus employed, it was deemed best not to publish it at the present moment for obvious reasons. But it is well to add here that the microphone system in a highly developed form will probably prove most effective in the anti-submarine campaign.

Eavesdropping Mine Fields to Guard Harbors

Another phase of the submarine problem is the protection of harbors against submarine attack. Heretofore huge nets and contact mines have been considered ample defense against the underwater enemy; but it has been demonstrated on at least one occasion during the present war that a submarine, piloted by a skilled navigator, can worm its way through a mine field and the heaviest of nets and reach shipping riding at anchor in what has been considered a safe berth. Furthermore, it is reported that the latest German U-boats are provided with a cutting device on the prow which permits them to cut their way through the heaviest net; hence the latter are no longer dependable.

How to protect harbors against submarine raids has been closely studied by Mr. Edward F. Chandler of New York city, whose various military inventions have been described in past issues of this journal. In the present instance Mr. Chandler proposes using electrically-fired mines which are equipped with microphones; in other words, mines that can "hear" the enemy and report their findings to a central point. Thus his system of mining a harbor possesses the advantage of the electrically-fired mine field in that each unit is not destructive until it is made so by pressing a firing key, and in no event is there the danger ever-present with the contact mine which does not distinguish between friend and foe. Again, his system has the advantages of the contact mine field inasmuch that the enemy courts destruction the moment he enters a mine field, no matter how carefully he may strive to avoid detection.



Submarine chaser following a submarine which has become ensnarled in a tell-tale net, and sliding a contact bomb down the steel wire

By studying the accompanying illustration it will be noted that Mr. Chandler equips his electrically-controlled mines with microphones, which are capable of detecting sound waves traveling through the water and of indicating the presence and strength of these sound waves at a central station. The mines are arranged in geometrical order, each mine forming a corner of a square in such a manner that the entrance to a given harbor is divided into many squares—a sort of checkerboard, as it were.

As a submarine enters Mr. Chandler's mine field

(Concluded on page 20)

The Horse-Power Race

Where the Winner is the Man Who Develops the Greatest Amount of Work

By A. E. Kennelly, Professor of Electrical Engineering at Harvard University and Massachusetts Institute of Technology

WHEN an athlete is running along a race track at a high speed, it is evident that he is exerting a very considerable effort. Nevertheless, except for air displacement and concussions between his feet and the ground, he is overcoming no external force; consequently his power is developed internally and his muscular work done internally. Under such conditions, it is very difficult to measure either the muscular work or the rate of doing it. When, however, an athlete runs uphill or climbs a rope, he lifts the weight of his body through an observable vertical distance against the direct pull of gravitation, and he then performs a measurable amount of exterior mechanical work in addition to the internal work. If a man weighing 75 kilograms (165.5 pounds) climbs a mountain 2,000 meters (6,560 feet) high, he will necessarily do external work to the extent of 150,000 kilogram-meters (1,085,000 foot-pounds).

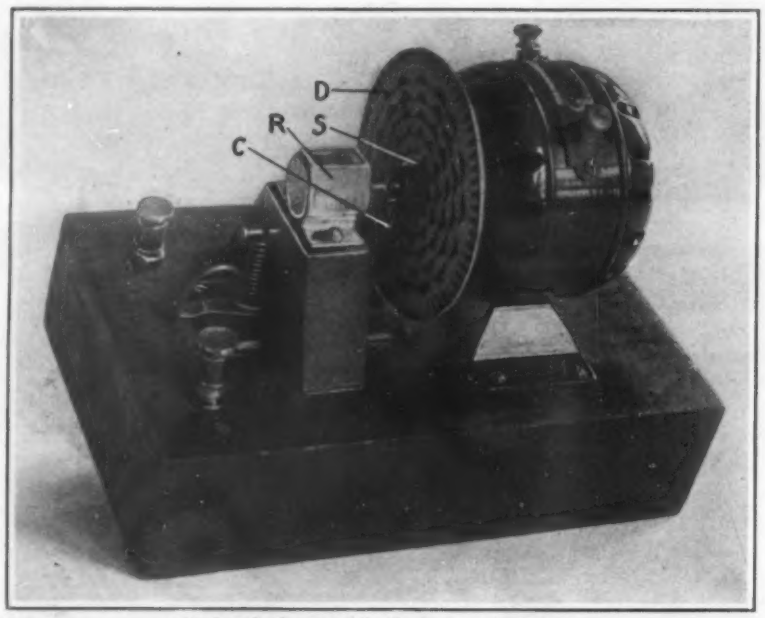
In the celebrated flea discussion in "Tom Sawyer Abroad," Mark Twain, speaking through Tom's mouth, makes it clear that in estimating the capacity of work, the element of time must be considered. Since the steam engine and the water wheel have come into general use for supplying power to our factories, the rate at which a strong man can do work has ceased to be of much industrial consequence; but the matter is clearly of athletic interest. No specification of the capabilities of an individual can pretend to be complete which omits all reference to the rate at which he is able to perform external muscular work. While such a rating must on its face be easy to obtain, it is a fact that less is known of the working powers of men than of those of animals. We have some idea of a horse-power, but hardly any notion of a man-power.

James Watt introduced our horse-power unit about 1775. By observations upon draft horses employed in raising water from a well, he found that a horse could raise 100 pounds while walking at the rate of 2.5 miles per hour. He added 50 per cent to this showing to allow for friction in the lifting and to make sure that a one-horse-power engine, on this basis of rating, should be free from all suspicion of weakness. This horse-power of 550 foot-pounds per second, or 76 kilogram-meters per second, or 746 watts, is admitted to be a high standard, in that a good horse, working six hours a day, would probably average about one-half a horse-power. On the other hand, working for less than one minute, he would surely be capable of developing much more power —just how much does not appear to be known.

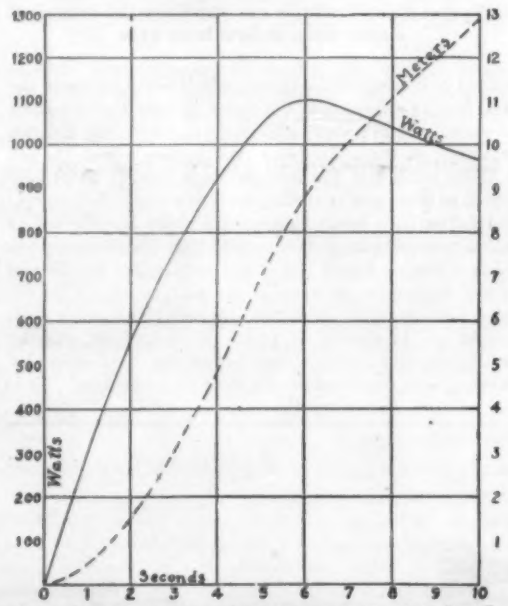
It is remarkable how little information is available concerning the power which a man is capable of exerting. Half a dozen fragmentary statements are all that can be found. It appears from these that the power of a man is in the order of 750 watts for a brief interval, say a fraction of a minute, and dwindles to 100 watts or less when maintained for some hours. It is plainly a matter of interest to ascertain the maximum external power of an athlete, and the conditions under which this maximum can be developed. Experiments in this direction have been made by a group of students at Massachusetts Institute of Technology, the results of which are summarized in this article.

In order to determine man-power, measurements were made of the height of a flight of stairs up which the athlete could run and thus carry his weight uphill in a noted interval of time. Multiplying his weight in kilograms by the height climbed in meters and dividing by the time of climbing, in seconds, the result is the average power exerted during the climb, in kilogram-meters per second. This result, when multiplied by 9.81, is converted into watts. In any event, it is to be emphasized that the figure derived is an average over a short interval, rather than an instantaneous observation for any single point during the trial.

If the flight of stairs is too low and short, it is found that because of starting inertia the maximum power is not fully reached, especially when the climb is made from a standing start. On the other hand, if the climb be made too long and high, the average power developed falls off through fatigue and slowing down near the goal. There is therefore a certain height and duration of climb which enables the man to develop his maximum external muscular power over the ascent. From experiments thus far made, it seems that a height of about 9 meters or 29 feet, which will be covered in approximately 6 seconds, is the best for developing maximum power from a standing start. The power developed by an athlete weighing 75 kilograms (165 pounds) was found to be $75 \times 8.83 \div 6 = 112.5$ kilogram-meters per second, or 1,104 watts, or about a horse-power and a half.



Timing device used in the horse-power race



Curve showing averaged horse-power developed and distance climbed for intervals up to 10 seconds

The curve shown herewith sets forth the averaged powers of one athlete as developed from a standing start on different heights of ascent, starting with 300 watts for a climb of 0.4 meters negotiated in one second, reaching a maximum of 1,100 watts for an 8.8-meter climb of about six seconds, and then falling off at greater heights and times. The curve of course varies with different men, both in its maximum and in the time at which that maximum is attained; but it is of the same general shape for all subjects yet tested.

The tests were made on flights of stairs in various places in and about Boston, of slopes ranging from 27.4° to 37.4°. So far as the results show, the variation in slope over this range did not noticeably affect the power developed. The height of the step, however, has a distinct effect. Low steps of say 15 centimeters or 6 inches each are free from objection only in that the athlete can take two of them at a stride. Steps higher than 35 centimeters were found to induce early fatigue. Bends in the ascent, as in the case of Bunker Hill Monument, naturally interfere with the development of speed and power. For the best output a straight, uniform ascent is needed. It appears unnecessary to provide more than 15 meters of total rise, and perhaps even 10 meters (32.8 feet) may be sufficient.

It is probable that, as in all other athletic events, steady training over the course would improve the speed and power. The record here presented is perhaps only a beginning, leading to probable higher, and possible much higher, performances in the future. The effect of a run along a level before the start up the stairway was found to raise the best average power over the ascent by some 200 watts, since it overcame the starting inertia and thus improved the time, without perceptibly advancing the moment when fatigue appeared.

One difficulty in measuring the power of an athlete over ascents of the kind described is the short duration of the climb. The event of maximum power is necessarily completed within ten seconds, ordinarily in six. With the use of the ordinary stop-watch a total error of $^2/_5$ second may easily occur in the dial record. In a run of seven seconds this represents an error of nearly six per cent. A timing mechanism of greater precision is therefore needed when accurate measurement is de-

(Concluded on page 16)

New York's Model War-Time Garden

AT one of the busiest corners of New York City—Union Square—a model back-yard garden is growing as a demonstration of what may be done with a small plot to relieve the threatened food shortage. Two squares, measuring 20 by 20 and 20 by 40 feet, are cultivated scientifically by Mr. John McCarthy, the gardener in charge of the square; and the cultivator is always ready to lay aside his hoe to answer the questions of prospective planters.

The ground of the model garden was correctly prepared and fertilized, and is planted to potatoes, cabbages, lettuce and onions; in fact, just the variety of vegetables that the average householder would care to raise. The operation of planting and tending the garden has been observed by thousands, and a large proportion of the spectators will surely benefit by this example. In addition to explaining the art of back-yard farming, Mr. McCarthy gives little pamphlets to all who are interested, with complete directions for starting a garden plot and tending it to produce results. This is essential, for the ignorance of the average city dweller regarding agriculture is limitless. One man complained that he had gathered no crop last year, although he had buried sections of potato in his back yard and left them alone until fall. Then when he went to dig up a bushel of potatoes, he found only four inches of grass and a collection of sturdy weeds covering the place he had planted several months before.

The demonstration garden, a project of Park Commissioner Cabot Ward, is an object lesson to the throngs of commuters who pass it daily. The sight of the growing things that look so fresh and appetizing is enough to make anybody want to shed his coat and dig in a garden of his own.

For those interested in back-yard gardening, this model truck-garden patch is maintained in one of New York's important squares

Inventions New and Interesting

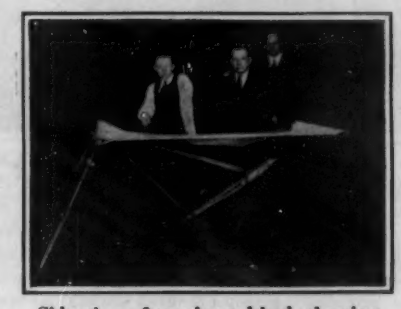
A Department Devoted to Pioneer Work in the Arts

A One-Legged Portable Bed for the Motor Tourist and Camper

ALMOST unusual bed is that recently introduced for the use of motor tourists and campers in particular and everyone in general who desires sleeping accommodations that can be rolled up into a readily portable bundle not exceeding fifteen or twenty pounds. It is the one-legged feature that stamps this new bed as a unique one; in fact, at first glance one wonders how it can maintain itself at all.

The one-legged bed, single sized, weighs about twenty pounds and is shown in one of the accompanying illustrations holding three men whose weights total 550 pounds. Aside from its portability, it will be noted in the illustration that, even though the men are sitting on one edge, the bed surface is not drawn out of center, sagged toward the middle, or even wrinkled out of alinement. It is also interesting to note the perfect alinement of the bed's only leg under this one-sided load.

One-legged bed holding three men or 550 pounds



Side view of one-legged bed, showing odd construction

The Patent Office records failed to reveal where this principle of an automatic surface tension had ever been applied to bed construction. The principle is as ideal as it is unique, because the surface tension is only proportioned by the weight applied; in other words, a child of 30 pounds will be as comfortable when sleeping on this bed as the heaviest grownup, but the surface tension will of course be altered in exact ratio with their respective weights. The principle of a compound lever properly balanced is the solution of the problem. The only wall fastening used in this demonstration was two pair of screw-eyes pinned in position by two nails merely to hold the bed leg in its lean-to position. On an automobile this lean-to position is easily made from either running board or the front bumper or the rear springs. It can also be tied to a tree or fence, or leaned upon two stakes in the ground.

Although the bed was created for automobile touring, its wonderful possibilities in other fields seem to be endless. The extremely light weight with comforts unexcelled in any bed, place it entirely out of the cot or hammock class, according to the designers. For larger beds of this type the construction simply has to be multiplied; that is to say, instead of a single leg several legs are used, as shown in other illustrations.

Weighing only 40 pounds, this portable bed readily carries a load of four adults and four children. Note the uniform tension

This automobile trailer, provided with two beds of the new type, offers sleeping accommodations for eight adults

A House Built of Rice Husks

IN an effort to overcome the sanitary and economic handicaps of nipa as material for house construction, the Director of Health of the Philippine Islands and his associates have designed a model house for the islands to be constructed out of a new fireproof material invented by the Philippine Health Service. This is composed of cement, sand, and nipa, or the husks of rice, reinforced by bamboo. For what is known as a first-class mixture the ingredients are one part each of cement, sand, and nipa. This material is formed into shingles for the roof, and slabs for the sides. The shingles weigh from 850 to 1,000 grams each. The slabs are one-half inch thick, and weigh about 6 pounds per square foot.

The first-class mixture will yield, for one barrel of cement, 450 to 500 shingles. The cost of each shingle, excluding labor, is approximately 1½ cents. The cost of each slab, 2 by 6 feet, excluding labor, is 35 to 40 cents. A house 6 meters by 10 meters requires 2,400 shingles. For the sides and partitions there should be 105 slabs. This allows for some breakage. The shingles and slabs are formed in molds and cured in water after being taken from the molds.

This quantity of material is for a house of five rooms—reception and dining room combined, sala or receiving room and sleeping room combined, bedroom proper, kitchen, and bathroom. A porch is added. The windows are double-paneled, with openings which let in the air in two places. For privacy, the lower part may be closed, leaving one opening for ventilation.

Efforts have been made for some time to devise material which could be used in the construction of houses that would be cheap enough to be within reach of the poor, and at the same time less combustible than those of nipa, the building material of the poor in the islands. The annual losses by fire resulting from the excessive inflammability of nipa have been a great burden on the people. This new composition, in the judgment of the chief of the fire department of Manila, gives the model house better fire-resisting qualities than those built of hardwood and roofed with iron. He places it in the same class with those built of brick with hardwood frames and tile roofs.

The life of the model house is estimated at 25 years. The life of the average nipa house is 10 years, although repairs have to be made every year. The cost of the model house is $250, practically the same as for nipa construction, including the yearly repairs.

In addition to the resistance to fire and the cheapness of this model house, it is far more sanitary than the nipa structure. The latter harbors rats and insects, is poorly ventilated as a rule, and rarely has enough room for the separation of the sexes or the isolation of the sick. The model house is provided with the principal sanitary facilities.

The Philippine Health Service has built several of the model houses as samples, and is doing all it can to have the new form of construction displace the old. A typical house is that shown in the accompanying illustration, which was built at Mariveles This illustration tells better than words the neat appearance of the new house, with its paneled walls, convenient window frames and attractive roof.

Model house built by the Philippine Health Service at Mariveles. This house is constructed of fireproof material invented by the Service

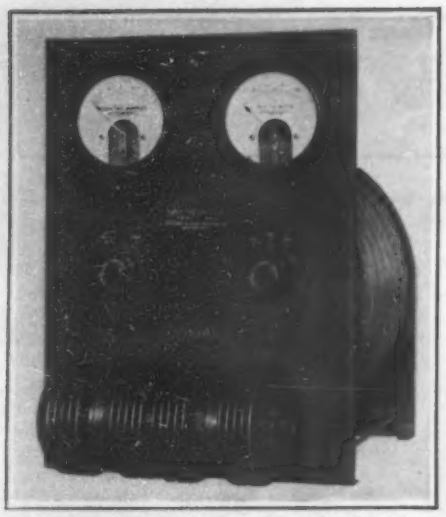
Wireless Equipment for the Submarine Chaser

REALLY to be an efficient naval unit the submarine chaser must be provided with wireless equipment; for otherwise it becomes a disconnected unit—a veritable "free lance," as it were—without means for receiving orders from the guiding genius of the fleet and without means for summoning aid or imparting invaluable information to other units of the fleet and to headquarters.

So, regardless of the numerous difficulties presented in the installation of wireless apparatus on board a craft as small as the submarine chaser, radio engineers early in the present war began to develop suitable wireless equipment. The task was not a simple one. Existing systems were entirely unsuitable to the conditions obtaining on board motor boats. But as time went on the engineers got the problem well in hand, and today there are numerous types of equipment especially intended for the small boat.

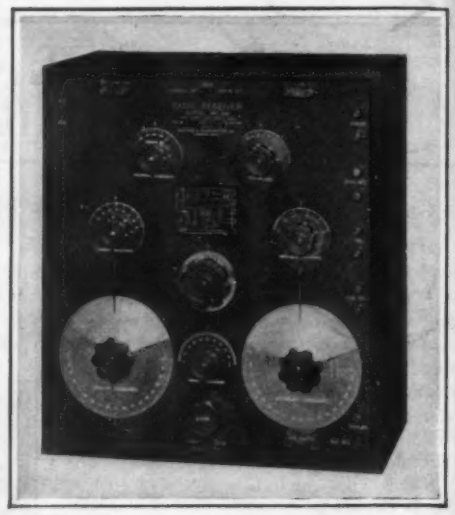
Among others two young radio engineers, Messrs. Cutting and Washington of Cambridge, Mass., have developed a one-half kilowatt set for the motor-boat station, which weighs 180 pounds and occupies a space of only four and one-half cubic feet. Power for the transmitter is furnished by a 500-cycle generator which delivers 500 volts at no load and 250 volts at full load. This generator may be driven by an electric motor, in the form of a motor-generator set, or by the main or auxiliary engine of the craft. It is connected through the transmitting key through a small mica dielectric condenser, which in turn is connected to the gap and primary of the coupling coil. The last three members comprise the exciting circuit. The secondary or coupling coil is connected in the usual way to the antenna and ground.

The remarkable range secured with the transmitter of this system is said to hinge principally on the



One-half kilowatt transmitter, showing the quenched gap at the bottom of the panel

Compact and highly efficient, this one-half kilowatt is especially suited for use on motor boats, the submarine chasers particularly



Wireless receiving set for use with either the audion or crystal type of detector

exceptional properties of the gap, which is quite short and equipped with electrodes of special material. During each successive half-cycle of the 500-cycle feed current the condenser is charged many times and discharges across the gap each time in a single impulse or half-cycle. This can b termed perfect "quenching." The first of these discharges sets up antenna oscillations. The condenser then begins to charge again in a rapid manner, and when it has reached a potential almost sufficient to break down the gap, the back e.m.f. induced from the antenna, which is still oscillating, triggers the system off in phase. This process continues throughout the main part of a half-cycle of the feed current, thus producing audible groups of sustained waves. This, it is held by the designers, is a most excellent method of exciting an antenna for two reasons: the gap quenches perfectly, insuring but one radiated wave and that at the natural decrement of the antenna, there being no "coupled circuit" effect. This makes for greater selectivity and receiving efficiency. Furthermore, the novel system eliminates the usual step-up transformer, a necessarily heavy piece of apparatus, and because of the low voltage of the oscillating circuit, cuts down the insulation required.

The new system is particularly suited to motor boats since it will operate with antennae of extremely small capacity. To introduce the required energy into a small capacity antenna with the usual type of apparatus, and where the antenna is inactive the greater portion of the time, makes necessary an exceedingly high maximum voltage; but with the new apparatus this is not the case.

Exceedingly compact and simple to operate is the receiving apparatus which completes the new wireless set. The standard receiver is of the cabinet type, and mounted on the front board or panel are three knobs by which the primary inductance, secondary inductance, primary capacity, secondary capacity, and the coupling of the two circuits are controlled. The standard set makes use of a crystal detector; but for those who prefer the audion a somewhat larger set has been developed which permits this or the crystal detector to be used by throwing a simple switch.

A Telephone Instrument That Is Designed After the Human Ear

By E. A. Dime

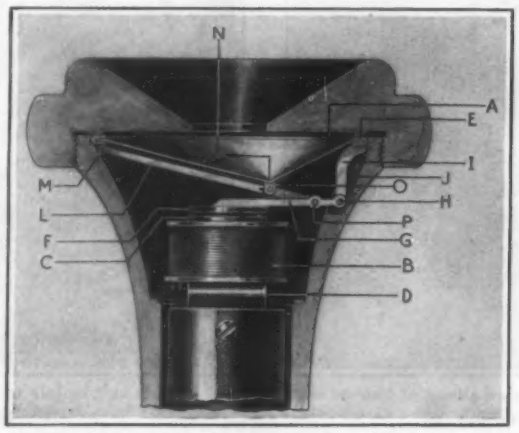
A REMARKABLE telephone receiver has recently been patented by Dr. Frank E. Miller of New York city, which in both construction and functioning bears a close relationship to the human ear.

Dr. Miller, who is a specialist in throat and ear diseases, has proceded on the theory that there must be coordination between the kinds of sound commonly produced by the human species and the shape of the tympanum of the ear, which tympanum primarily conveys the disturbance of sound waves to the remaining mechanism of the ear.

Now the tympanum, or the human-ear diaphragm, is not disk-shaped like the metallic diaphragm common in telephone receivers. On the contrary, it is very materially dished and the dishing is eccentric, the apex of the dished configuration being called the umbo. Dr. Miller has discovered that the resonating cavities of the human voice anatomy bear the proportion one to the other of 3:4:5. These cavities are respectively the laryngeal cavity, the nasal cavities and the mouth cavity. It also appears that the human tympanum has likewise three vibratory zones in different major planes, but merging one into the other, and these roughly approximate the same proportion of 3:4:5.

It is the object of Dr. Miller's invention to form and combine means for artificially coördinating sound vibrations and electric variations in a manner analogously following the organic mechanism of the human ear and including a sound-functioning diaphragm which is eccentrically dished in a manner approximating the human tympanum, and electromagnetic means to function with said diaphragm. The invention also has a lever system of a type which simulates the system of bone levers in the ear. Furthermore, there are introduced into this artificial sound-functioning mechanism as many of the similar organic refinements of mechanism present in the human ear as can be corelated in an artificial mechanism for the best translation of sound with its several tonic variations.

Exactly what the reason is that the human sound responding diaphragm, the tympanum, much more faithfully responds to sound-vibrations than does a flat



Sectional view of a telephone receiver designed after the human ear

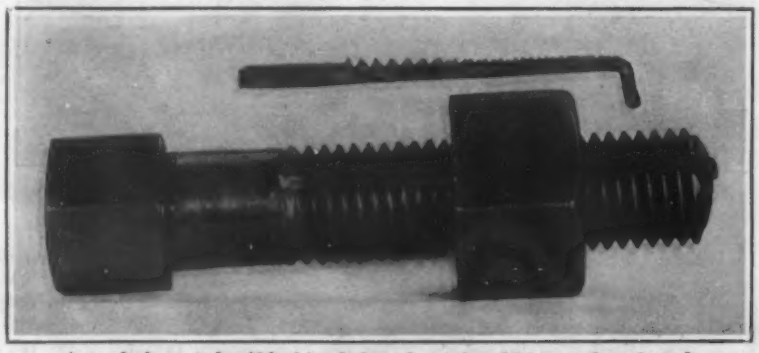
disk-shaped diaphragm may not be subject to conclusive deduction from the study of anatomy, but the fact remains that the resounding chambers in the human voice-anatomy are fundamentally three in number and of the relative volumetric proportion 3:4:5. Additionally, it is an unanswerable fact that a circular disk cannot assume a nodal arrangement which responds equally well to each of three sets of pitch vibrations bearing the proportion 3:4:5. It is the inventor's belief that the dished or concave shape itself of the human tympanum individually increases the facility of nodal arrangement in a manner suitable for selective response to any one of or any combinations of the usual tonic variations of the human voice. The doctor is also of the opinion that the eccentric dishing or possibly even the application of lever mechanism or other connecting means to an eccentric locality on a circular diaphragm, even though the same be not dished, may contribute alone to the same useful result.

In the mechanism of the human ear the cup-shaped tympanum is vibratorily connected with the auditory nerve, first through the medium of the malleus lying alongside the convex face of the tympanum and connected at its manubrium directly to the umbo or apex of the convex side of the tympanum. In some embodiments of his invention Dr. Miller has simulated this human mechanism in a lever system serving as a part of means for coöperatively relating the electric circuit means with the diaphragm. For example, in the accompanying illustrations the diaphragm, *A*, and coils or bobbins, *B*, are relatively arranged, and the cores, *D*, have their faces or pole-pieces, *C*, terminating adjacent to the end of the coils or bobbins in a plane parallel to the plane of the margin, *E*, of the diaphragm, *A*, and an armature, *F*, directly coöperates with the cores, *D*, and is mounted on a lever means, *G*, fulcrummed by the hinge, *H*, supported by a bracket, *I*, in a suitable recess, *J*, in the housing of the receiver, and fixed to the ring, *K*. Another lever, *L*, is fulcrummed by the hinge, *M*, and extends down alongside the long convex face of the diaphragm, *A*. At the umbo, *N*, of the diaphragm is attached a lug, *O*, connected by a pin passing through the slot in the lever, *L*, the far end of which is hinged by the pin, *P*, to the lever, *G*. In this manner vibrations between the armature, *F*, and the umbo of the diaphragm have a mechanical connection through a system of levers.

A satisfactory manner in which to construct the cup-shaped diaphragm is first to have an expert engraver faithfully reproduce by eye-comparison a replica of both the anterior and the posterior walls of a freshly dissected human tympanum. It has been found that this means of reproduction is more accurate than the attempted measurements with the medium of instruments With the wooden replica thus constructed by the engraver as a miniature pattern, form-corresponding full-sized male and female dies can be formed, the operative portions of which should approximate at least two inches in diameter. Sheet steel or sheet metal of the kind sometimes known as tin-type metal, or of the kind commonly employed in the flat diaphragms in telephone receivers of commerce, has been found to be suitable material for the construction of the diaphragm. In one embodiment of the mechanism the diaphragm may be formed of such material as celluloid, parchment, sheepskin, or any of the materials commonly used in making drum-heads and the like.

Providing the Bolt with a Nut That Stays In Place

SIMPLE and effective is the method of providing a bolt with a nut that stays in place, depicted in the accompanying illustration. Briefly, this method, which is the invention of Joseph Bohrheimer of Shamokin, Pa., consists in cutting a slot or keyway ir the shank of the bolt, and placing in this keyway a key made of soft material such as brass or aluminum. The key member is wedge-shaped, having a somewhat slight taper. As the nut is screwed on the shank it cuts its own thread on the wedge-shaped member; and as it advances it meets with steadily-increasing resistance because of the increased size of the key section. The result is that the nut is practically jammed in place and can be moved only by considerable physical force applied with a wrench. Obviously, this method permits a bolt to be used any number of times, since extra keys can be procured at a very small cost.



A newly-invented self-locking bolt and nut, in which a wedge-shaped key is used

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RECENTLY PATENTED INVENTIONS

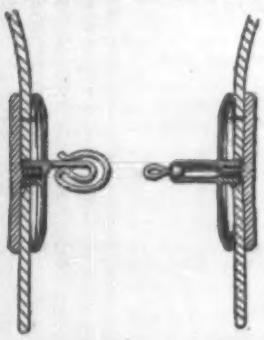
These columns are open to all patentees. The notices are inserted by special arrangement with the inventors. Terms on application to the Advertising Department of SCIENTIFIC AMERICAN.

Pertaining to Apparel

LIGHT-PROOF AND SANITARY SKIRT.—STELLA MOSCOW, 35 Prospect Park, S. W., Brooklyn, N. Y. This invention has reference to an improved skirt and particularly to an improved arrangement of parts whereby a thin skirt body may be produced and an opaque protecting member arranged adjacent thereto for preventing the passage of light.

GARTER.—J. C. ROGERS, care of Dierks Lumber & Coal Co., Gates Bldg., Kansas City, Mo. The invention provides a garter arranged to permit the user to conveniently place the garter in position on the leg and attach it to the hose or stocking, and to draw the leg band taut around the calf of the wearer's leg by the downward pull exerted by the hose or stocking.

CUFF BUTTON.—L. L. HOUSER, 219 E. 4th St., Mishawaka, Ind. This invention is so designed that a cuff can be easily buttoned and unbuttoned, the sections of the buttons being so made that they can be clamped in the button-



CUFF BUTTON

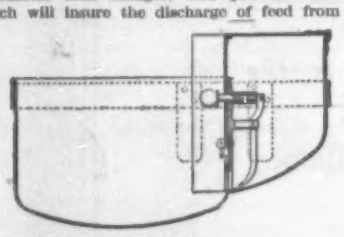
holes and thus securely attached to the sleeve at all times. It provides a hook on one section of the button and an eye on the other section, whereby the sections can be easily and quickly connected and disconnected, and when connected accidental detachment is prevented.

Electrical Devices

AUTOMATIC CIRCUIT CLOSER FOR ELECTRIC HEATERS.—M. H. FARLEY, 4032 45th St., S. W., Seattle, Wash. This invention provides an automatic thermostatic switch or controller for use in connection with an electric sad iron, the same being adapted not only to break the circuit when the iron attains a certain predetermined degree of heat and to again close the circuit when the temperature of the iron becomes reduced, but it is of such a nature as to be easily and delicately adjusted so as to vary that degree of heat, which makes the device adapted for higher or lower temperatures according to the desire of the operator.

Of Interest to Farmers

SLOW FEED MANGER.—J. I. BROWN. Address F. M. Brown, Shippan Point, Stamford, Conn. This invention relates to mangers and particularly to what may be termed a semi-automatic feed manger, and provides means which will insure the discharge of feed from a



SLOW FEED MANGER

storage reservoir into the manger proper. It provides a manger having a main bowl and a storage compartment, together with means operable by the animal for insuring a proper feed from the storage compartment to the bowl.

SILO SEAL.—F. B. CRAWFORD, Atlanta, Mo. In the present invention the improvement has reference to seals for silos for covering the upper surface of the silage for preventing the spoiling of the upper zone thereof, this being accomplished by excluding the air from contact with the silage.

Of General Interest

ENVELOP.—P. A. HOFFMAN, care of Smead Mfg. Co., Hastings, Minn. This improvement has for its object the provision of a construction which may be used as an envelop for receiving any suitable paper or as a box, envelop or container for the purpose of filing documents of various kinds and also for the purpose of mailing booklets and the like.

PINCUSHION.—F. J. DOWLING, 425 W. 124th St., New York, N. Y. Among the objects of the invention is to provide an easily manipulated and reliable means for gripping and holding the resilient part of the cushion or the cushion proper. Also to provide a base of frame adapted for the utilization of a plurality of bivalve shells, constituting the jaw portions or parts that hold the cushion.

MOUNTING FOR PRESSER-BAR ACTUATING LEVER FOR SELF-FILLING FOUNTAIN PENS.—E. F. BRITTEN JR., 173 Broadway, New York, N. Y. The general objects in this case are to improve and to simplify the mounting for the presser-bar actuating lever whereby boring of the barrel of the pen for the reception of the fulcrum pin for the lever is avoided, the lever being fulcrumed in a boxlike frame or member set into the lever receiving slot of the pen barrel.

Hardware and Tools

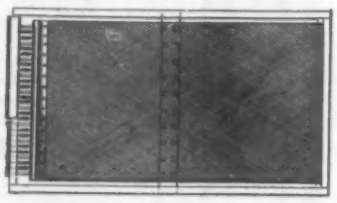
PERMUTATION LOCK.—H. A. TOUISSAINT, Caseyville, Ill. The lock is especially adapted for locking fly wheels and the like, wherein a bolt is provided and a casing in which the bolt is mounted and adapted to be arranged on a fixed support adjacent to the wheel, the bolt having a shoe for engaging the wheel to lock the same, and wherein interlocking mechanism is provided in connection with the bolt and the casing, for holding the bolt in locked position.

Heating and Lighting

FURNACE AND EVAPORATOR.—J. L. PIERCE, 34 Escolta, Manila, Philippine Islands. The apparatus is primarily for use in drying copra, but may be used for evaporating fruit, vegetables, etc., and the invention provides a container for the matter being evaporated, means for heating air, means for delivering the heated air to said container so as to prevent the flames of the air heater from reaching said container, and a plurality of separately removable trays for the matter being evaporated in each of a plurality of separate compartments, all of which are in operative connection with the heated air supply.

Household Utilities

BED SPRING.—J. L. YATES, 479 Morris Ave., Bronx, N. Y. An object in this invention is to provide resilient means for the spring for operation independently of the adjusting means. Another object is to provide resilient supporting means for the intermediate portion of the spring,



BED SPRING

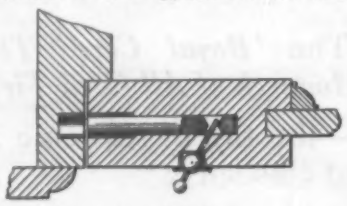
and still further to provide an improved guard for the adjusting mechanism. The engraving shows a plan view of the entire bed spring structure, one part of the guard being broken away to disclose the adjusting mechanism.

INSECT TRAP.—J. R. VAN J. BLINCK, Tampa, Fla. Among the objects of this invention is to provide an insect trap capable of entrapping all kinds of small insects and especially ants. Another object of the invention is to provide a trap that automatically seals against egress once the insect is within it.

WASHING MACHINE.—J. J. WALSH, 215 Inslee Place, Elizabeth, N. J. The invention provides a machine which is particularly adaptable for use with washtubs; provides a collapsible machine so that the same can be stored in a comparatively narrow space; and provides a machine which can be easily and quickly secured or removed from a washtub.

Machines and Mechanical Devices

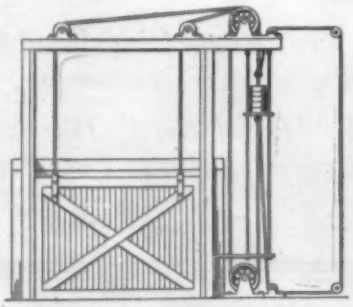
BOLT LEVER.—D. WALTER, Grosvenor House, New Church Road, Hove, Sussex, England. The invention relates to sliding bolts for doors, casements or other applicable devices wherein



BOLT LEVER

the bolt member is moved longitudinally by means of a pivoted lever the inner end of which engages a longitudinal slot or aperture formed within such member with means for securing such lever in either extreme position.

DOOR OPERATOR.—L. L. SHOCKLEY, Columbia, Mo. The invention provides a device especially adapted for barn and garage doors, wherein means is provided for counterbalancing the door, to permit it to be moved vertically



DOOR OPERATOR

with a minimum of effort. With the doorhanger, there are no rollers or track for rollers to jump from, and the door cannot stick as may the rolling door. Since the door is counterbalanced it moves without effort.

PAPER FEED CONTROLLING APPARATUS—T. J. BEREGH, JR., 92 William St., New York, N. Y. Among the principal objects which the present invention has in view are: to avoid feeding paper in a damaged condition to printing presses; and to arrest the operation of said presses in the event that paper in a damaged condition is being fed thereto and prior to the damaged portion of said paper reaching the platen of said presses.

CARD PUNCHING DEVICE.—J. W. FRITCH and DELIA E. HOOPES, Washington, D. C. The invention provides a device for punching cards, such as those which are used for statistical data, as for instance in compiling statistics for the census or, for similar uses. It provides a device in which the cards are moved automatically into position, are then punched and are automatically removed and delivered to a receiver.

PROPELLING WHEEL.—R. C. HILL, Box 1017 Memphis, Tenn. This invention provides a wheel wherein a series of blades or vanes is so mounted that the blades will enter the water in vertical position, will move in a line perpendicular to their planes throughout their contact with the water, and will again move vertically out of the water.

Musical Devices

AUTOMATIC STOP FOR TALKING MACHINES.—A. JUNOD, 272 W. 34th St., New York, N. Y. The stop coöperates with the brake of the talking machine and automatically applies the brake to the plate or record support when the end of a sound groove is reached by the stylus. The stop is sensitive and can be made to apply the brake as soon as the end of the sound groove is reached or at a certain interval of time after the end of the sound groove has been reached by the stylus.

Prime Movers and Their Accessories

ROTARY INTERNAL COMBUSTION ENGINE.—H. C. WELL, 1175 Wyatt St., Brooklyn, N. Y. This invention provides an engine with a rotor having chambers which extend through the periphery of the rotor and in which a gas is compressed from the compression chamber of a casing in which the rotor is rotatably mounted; the gas in the chambers of the rotor being ignited at a point in the rotation of the rotor, the expounding gas passing from the chambers in the rotor to an expansion chamber in the casing where it acts against the abutment at the end of the expansion chamber, and a piston which is mounted in a radial guideway in the rotor.

Railways and Their Accessories

RAILWAY SWITCH OPERATOR.—W. A. ROBINSON, 289 W. 142d St., New York, N. Y. This invention relates to means for operating switches, and provides means under the control of an engineer or motorman for accomplishing this result at will. It provides means for returning a switch to normal position, if desired, also under the control of the person operating a car or train. It accomplishes these results by mechanical means as distinguished from electrical means likely to get out of order, especially in wet or winter weather.

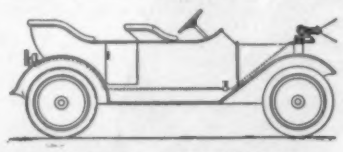
Pertaining to Recreation

TALKING DOLL.—B. E. LLOYD, 309 Jane St., W. Hoboken, N. J. The more specific object here is to provide means for articulating the sound issuing from the reed, such means including an aperture having a resilient lip and spaced stoppers or valves which are passed through the aperture and coöperate with the lip to cause the articulation of the sound for producing a word, such as "mama".

TOY.—D. V. TANTLINGER, 75 A Ave., Lawton, Okla. This mechanical device is for use in hurling a boomerang which includes a movable member for receiving one end of the boomerang and pivoted to a stationary member, said movable member being adapted to be adjusted against the tension of a resilient element so that when released the boomerang will be hurled therefrom with great force.

Pertaining to Vehicles

INDICATOR FOR MOTOR VEHICLES.—B. M. TAKAHASHI, Harlowton, Mont. The mechanism provided is capable of being attached to existing motor vehicles for indicating to pedestrains, chauffeurs and drivers of other vehicles, traffic officers and the like, the direction which the driver of the motor vehicle intends



INDICATOR FOR MOTOR VEHICLES

to take, to the right, the left, or straight ahead, and wherein a visible signal is provided mounted to swing to either side and normally occupying a central position, together with controlling mechanism under the control of the chauffeur for swinging the signals.

Designs

DESIGN FOR A TRAY.—I. FREID, 811 E. 15th St., Flatbush, Brooklyn, N. Y. In this ornamental design for a tray the article is of oblong form, constructed to hold cigar ashes, nut shells, etc., and clamped to the edge of a plate or similar object.

NOTE.—Copies of any of these patents will be furnished by the SCIENTIFIC AMERICAN for ten cents each. Please state the name of patentee, title of the invention, and date of this paper.

The Horse-Power Race

(Concluded from page 12)

sired. The obvious solution is an electric device, with contact made as the athlete's weight depresses the first step, and broken correspondingly at the top of the climb. In the tests under description, such a device was used in which a motor speed of 60 revolutions per second was attained, insuring accuracy within $^1/_{60}$ second.

It is interesting to note that in the regular running races over a horizontal track, the best maximum speed over the course, as taken from world's running records, is found in the neighborhood of the 100-meter (110-yard) dash, for which the record is 10.6 seconds, representing an average speed of 9.43 meters per second. With shorter distances, the speeds over the course are less, owing to inertia at starting. With longer distances, the speeds fall off, owing to fatigue. The external power of the athlete is here very small. The best time interval for maximum speed and external power, on a stairway, appears, from the results here reported, to be about six seconds. It is too early, however, in the development of uphill records, to take this result as more than a preliminary one.

In order to make the uphill power accomplishment a public athletic contest, it would only be necessary to weigh, just before the event, the athletes offering to enter the competition, in the garments of their own selection. If the weights of the men were nearly alike, they would be brought into equality with that of the heaviest man, by imposing upon the other men the proper extra weights. If the men's weights differed too much to allow of this being conveniently done, the men might be divided into light, medium and heavyweight classes. The men of each class, being brought to equal weight, would be started side by side, from rest, at the firing of a pistol. They would dash uphill on the stairway, just as in an ordinary horizontal race, and the man reaching the assigned goal level first, would be the winner. The height of the goal would have to be selected at that value above the starting point which would most probably permit of the attainment of a maximum watt development. The announcement of victory would naturally be stated either in watts, or in kilogram-meters per second, over a standard course.

Experiments have not yet been made as to the effect, on his external power output, of loading the athlete with weights. It has only been observed that very heavy loading reduces the output. Moreover, it has not yet been ascertained whether light or heavy men have any essential advantage in such external muscular output. These should be interesting questions to answer by further experiment. The maximum wattage of an athlete is a statistical property that he enjoys, as a strong man, and which it should be of interest to determine. Moreover, the maximum wattage per kilogram of body weight, should also be a noteworthy secondary specification of an athlete. In the case here presented, the maximum is 1,104 watts, which for a 75-kilogram man (including clothing), corresponds to 14.7 external watts per kilogram of his total weight.

It may well happen that, in jumping, the muscular power of an athlete exceeds that which he can exhibit in running uphill. In a pole-vault, a height of four meters has been slightly exceeded. This means lifting the center of gravity of the body say three meters. An athlete weighing 66.7 kilograms, making such a jump, would do work, in lifting his body, to the amount of 200 kilogram-meters. If the vault to the level of the pole occupied one second, this would represent an average lifting power of 200 kilogram-meters per second or nearly 2,000 watts. It must be remembered, however, that much of this power is derived from the running start. In any case, jumping-up wattage would necessarily be a very different event from running-up wattage. While it would be interesting to measure the best maximum power in any or all kinds of suitable athletic efforts, it would seem that the wattage event most likely to enlist general competitive interest would be the upstair dash.

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"Preparing To Prepare"

(Concluded from page 8)

instance above another with any idea of relative importance, but merely to show the diversity of the problems of the General Munitions Board and the way it solves them, consider the totally unrelated subjects of pressed steel, optical glass and artillery wheel spokes.

The Pressed Steel Committee—which has to do with steel helmets, for one thing—started out to do something, and do it quickly. Its method was truly American. It hired a pressed steel engineer who knew all about all the pressed steel works in the country. It had every blue print and specification calling for any kind of pressed steel sent to it from both Army and Navy. It had the engineer read those blue prints, and recommend instantly *which work should go to which factory.* Thus, helmets were not recommended to a concern better fitted to turn out railroad cars, nor oil tanks to concerns better able to make helmets. The resulting saving of time and money has been something no one has had time to calculate!

Optical glass—meaning glass of special powers used in telescopes, field glasses, surveying instruments, gun sights, range finders, etc., has always been imported from Germany and Austria.

While the United States was neutral, the great optical works had enough reserve stock for our wants. But not for war purposes. So a supply was developed. This was missionary work pure and simple. It meant an appeal to the patriotism of those glass-making firms who had little to gain and much to lose in starting in a difficult, dainty and little known branch of glass making. But it was done—done as the General Munitions Board has done most of its work, with care, skill and promptness, and now, no matter how many things to look through our million men may need, *we will have the glass*—and the factories to work it—to supply them.

It takes seasoned timber of fine quality for artillery wheel spokes. There wasn't enough in sight at the beginning of the war. And guns, no matter how well made and supplied with ammunition, cannot be picked up and carried around. A gun is a piece of apparatus which shoots, but it has to have wheels, a caisson, ammunition wagons, all meaning wheels, wheels, wheels. The Army Vehicles Committee arranged for an adequate supply by suggesting purchase of green lumber, months ago, and finding the kilns where it could be seasoned. A detail? So is a horseshoe nail or the keystone of an arch, or the weakest link in a chain. Successful war results from care in details!

It would be much easier to write pages than to stop—much more satisfactory to take up in detail the splendid work of preparing to prepare which the General Munitions Board has accomplished. But it would be distinctly unjust to close even so general a story without saying to those pessimists who believe that the only patriotism in America is dollar-dictated, that the most important work done by the General Munitions Board, and the many splendid, high-priced civilians who are a part of it and its various committees, has been done entirely as a labor of love of America, and without salary, or thought of commission, or of profit.

And that's the underlying reason—that spirit and what it represents—why our end of this war is going to be successfully prosecuted.

Mobolizing Educational Institutions

AT a conference held on May 5th between administrative officials on 180 leading institutions of learning and a committee of the Advisory National Defense Commission, resolutions were adopted recommending that the Bureau of Education and the States Relations Service of the Department of Agriculture prepare a comprehensive program of coöperation between the Government and the educational institutions of the country looking to the most effective use of the latter during the war. The meeting also urged that all colleges and universities modify their calendars and curricula.

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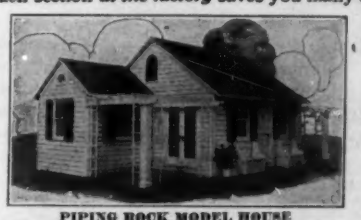

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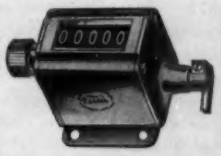

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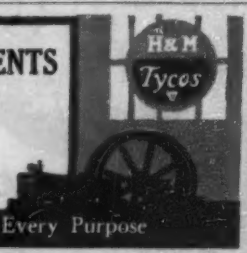

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Those who are interested in the trade opportunities listed in this column, can obtain the names and addresses by complying with the following simple rules: 1. Write only one inquiry on a sheet. 2. Always give the serial number. 3. Write on your own business letterhead. The SCIENTIFIC AMERICAN assumes no responsibility for the financial standing of concerns or individuals. Address all communications to the Query Editor of the SCIENTIFIC AMERICAN, Woolworth Building, New York.

568.—A banking firm in The Netherlands wishes to be placed in communication with American manufacturers and exporters of mining machinery.

569.—A merchant in France is in the market for gold pens, especially for stylographic and fountain pens. Quotations should be made c. i. f. French port. Cash will be paid. References. Correspondence should be in French.

570.—A business man in Spain desires to secure an agency, on a commission basis, for the sale of low-priced automobiles. He will purchase sample car if satisfactory terms are offered. Quotations should be made c. i. f. destination or Barcelona. Correspondence may be in English. Reference.

571.—A firm in Switzerland wishes to secure an exclusive agency for the sale of American motor cars. Quotations should be made c. i. f. Cette, France, or f. o. b. American port. Correspondence should be in French. References.

572.—A man in Spain would like to purchase railway freight cars, or secure an agency for the sale of same. Quotations should be made c. i. f. Spanish port. Correspondence should be in French or Spanish. References.

573.—The purchasing agent of a firm in Argentina, with offices in the United States, desires to purchase and secure exclusive selling rights for agricultural implements and machinery, such as corn shellers, gang plows, sulky plows, corn-planter attachments for gang and sulky plows, disk plows, single and two-row listers, disk harrows, spike-tooth harrows, grain drills, broadcast sowers, corn planters, cultivators, alfalfa mowers, hay rakes, hay loaders, hay baling presses, binders, combined binders and headers, corn pickers, windmills and towers, manure spreaders, thrashers, etc. Correspondence should be in Spanish and in duplicate. References.

574.—A firm in Australia desires to be placed in communication with American manufacturers and exporters of tubes suitable for close-joint and screwed brazed conduits. Full information as to size, quantity, etc., may be obtained.

575.—A firm in Italy wishes to buy coffee machinery, such as machines for roasting, cleaning, washing, drying, etc. Catalogues should be submitted. Correspondence may be in English. References.

576.—A man in France desires to purchase machinery for felling trees. Correspondence should be in French.

577.—A man in Nicaragua is desirous of buying complete machinery and equipment for the manufacture of dairy products, such as cooling and sterilizing apparatus, etc. Quotations should be made f. o. b. New York. Cash will be paid. Correspondence may be in English. References.

578.—An active young American correspondent in Costa Rica desires to secure an agency for the sale of hosiery and other American goods of every description.

579.—A civil engineer, residing in the Province of Quebec, Canada, is desirous of representing a firm in his locality, for machinery, mechanical devices and specialties, or engineers', school and office supplies, etc. Will give most part of his time to this representation, and if necessary, will go and get acquainted with details at headquarters. Correspondence, French and English, solicited.

580.—A correspondent at Sydney wants the names and addresses of makers of machines suitable for the manufacture of oakum, also for spun yarn and other small rope.

581.—A business man in Italy wishes to purchase 10 to 25,000 tons of hard and soft Bessemer steel in ingots, billets, bars, plates, sheets, wire, etc. Correspondence should be in French or Italian. Reference.

582.—A shipbuilding company in Canada desires to purchase one 50 to 60 horsepower crude oil burning Diesel engine, with a speed of 8 miles per hour, suitable for auxiliary fishing vessel. Quotations should be made f. o. b. port of shipment. Cash will be paid. References.

583.—A company in Australia desires to purchase machinery used in grinding and polishing terrazzo, silicate, and other similar floors, etc., and all kinds of machines, tools, etc., used in the manufacture of concrete treads, sills, blocks, tiles, and concrete work of like nature. Quotations should be made f. o. b. New York or San Francisco. Payment will be made by cash against documents.

584.—A merchant in Australia is in the market for coal-pulverizing machinery, the pulverized coal to be used for fuel for locomotives and stationary engines.

585.—An agency is desired by a company in New Zealand for the sale of electric lighting outfits suitable for private houses. Quotations should be made f. o. b. New York or San Francisco. Payment will be made by letter of credit. References.

586.—A man in British East Africa is in the market for slates, slate pencils, lead pencils, pens, penholders, erasers, writing tablets for ink and pencil, composition books containing 48 to 64 and 90 pages, plain envelopes Nos. 5 and 6, ink in 3- or 4-ounce bottles. The slates should be about 7 by 10 inches or 8 by 11 inches inside the frame. This frame must be of plain wood, with the corners strengthened by iron tenon securely pinned. Quotations should be made c. i. f. Kilindini, or f. o. b. New York. Payment will be made by cash against documents. The slates and ink should be packed in sawdust.

587.—A man in Spain wishes to be placed in communication with American manufacturers and exporters of automatic pianos. Two catalogues should be mailed at different times. Quotations should be made f. o. b. New York.

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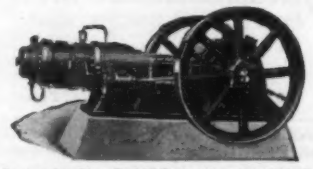

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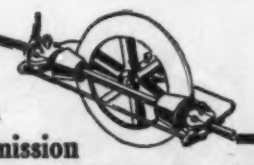

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Re-introducing the Concrete-and-Steel Fortification

(*Concluded from page 3*)

subterranean chamber which in turn is reached by an underground passageway from the rear. Each machine-gun pit is made sufficiently large to accommodate a machine gun and gunner, and is provided with a long horizontal slot a few inches above the ground. The pits are so placed as to give a wide range of fire and also make possible an enfilading fire calculated to prove most disconcerting to advancing troops. In the subterranean chamber the Germans keep their stores and ammunition, and also seek shelter when the artillery fire of the attacking forces compels them to do so. It is understood that the machine-gun pits of the Mebus are carefully concealed so that they are invisible until the attackers come within their fire; and in the latest type it is reported that the pits are arranged to be raised and lowered at will, in order that the cupola may only be raised and in position to fire when artillery fire has ceased and the hostile infantry is within range.

For their artillery the Germans also provide concrete shelters, although this practice does not extend to the heavier artillery for the reason that the latter, being cumbersome, cannot be lifted or dragged out expeditiously in the event of forced retreat. Thus, the heavier pieces of artillery are more or less exposed to the fire of the Entente guns, while the field guns are placed in concrete shelters not unlike those for machine guns. These shelters are heavily concreted at the top to protect the cannon from high-angle fire, while a frontal parapet of earth is relied upon to ward off low trajectory shells.

It is almost impossible, under battle conditions, to remove guns mounted in these concrete emplacements, hence in the event of a forced retreat they must be abandoned to the enemy. It has been stated on good authority, however, that the Germans are using mostly old cannon or worn-out cannon in these concrete shelters. This sounds feasible for the reason that the Germans use these cannon to repel infantry attacks at close range, and even a cannon with little rifling left is capable of firing shrapnel with sufficient accuracy for this class of work. Guns of medium caliber, it appears, are placed in separate shelters, while the 77-mm. field pieces are grouped together in shelters consisting of a series of concrete arches. In either case the front face is wide open, and the gunners depend upon earth parapets, armor plate and screens for protection against horizontal fire.

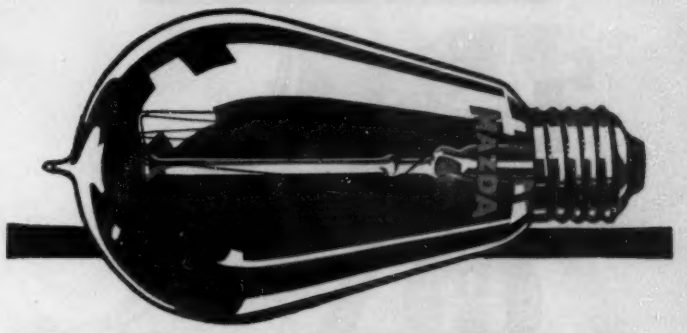
While the concrete defenses of the Germans appear to be proof against field-artillery fire, the fact remains that they rapidly crumble before the drum fire of the British and French heavy artillery, particularly the howitzers. Once a German concrete shelter is discovered by an Allied airman its fate is sealed, for one direct hit from a heavy gun usually puts it *hors de combat*. Thus the Germans, too, must rely on camouflage or the art of military concealment, which, after all, is the greatest protection known today.

The Microscope and Miladi's Hose

(*Concluded from page 7*)

possible hem was sewed to prevent ravelling—the correct mission in life of a hem. This was so narrow, in fact, that the garter must of necessity be clasped below it and not above it; then a softer and heavier yarn which does not lend itself readily to runs was used in the eight inches at the top of the stocking. The garter, of course, is clasped in this part of the fabric. A study of the photographs will show that the strain is now distributed with considerable uniformity throughout the entire length of the garment, so that danger of runs is done away with. The efficacy of the remedy is demonstrated by the fact that upwards of 400,000 dozen hose knit in this way—about ten million individual stockings—have been delivered, and the first complaint of runs is yet to come.

A point which should not be missed is that these are photo-micrographs—the result of looking through a microscope with



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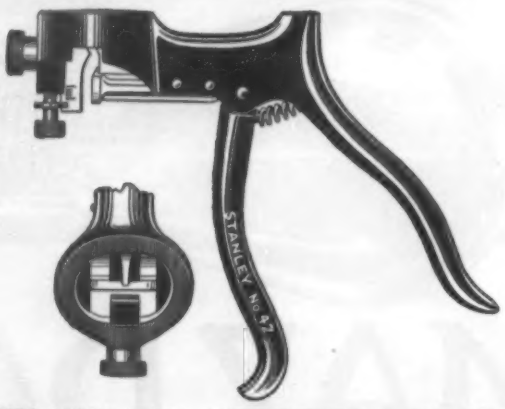

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a camera instead of with the eye—and not greatly enlarged direct photographs. The latter, after a certain point, would be of value only as throwing light upon the photographic process itself, since no emulsion possesses a sufficiently small grain to reproduce the microscopic details of the subject. The photo-micrograph, on the other hand, furnishes a perfect means for recording and making permanent the immediate results of microscope work. Not only is it possible to examine the print under the most favorable conditions, and as often as desired under the same conditions, but in this way as in no other can the actual investigator bring his results and conclusions clearly before the eye of the executive. On its very face the photo-micrograph is of tremendous value.

Another thing which the present example brings home is the very workaday character which industrial science so often assumes. We have shown in these columns how the Mellon Institute scientists spent months and years in reducing the homely process of bread baking to an exact science, and in looking into the technology of washing a shirt; and now we have a picture of the application of science to no less personal an article than a lady's stocking. The conception of science in the industries usually brings to mind a picture of gigantic metal reduction works, or at least of a plant in which are carried out elaborate processes for the recovery of millions of dollars from some nasty mess which has always heretofore been thrown out as worthless. That industrial science comes much closer to us all than that is now obvious.

The Submarine Problem—VI.

(Concluded from page 11)

it indicates its presence by the sound it creates. The hum of the motors and the beating of the propeller are picked up by the microphone in the mines nearest the submarine, causing a certain square of a checkerboard indicator to flash up at the central station. This indicates to the operator the square in which the submarine happens to be at that moment; and in this manner the operator is able to follow the course of the submarine as it worms its way through the mine field by closely watching the different squares of the luminous indicator flare up and die out one by one.

Now, then, since the mines are spaced a considerable distance apart; it would be obviously impractical for the operator to explode the four mines forming the corners of the square in which the submarine happens to be. To this end Mr. Chandler has introduced what he chooses to term a "precision indicator," which is a sensitive form of electrical indicator which makes it possible to determine what mine the submarine is nearest to at any given moment.

After the operator has followed the progress of the submarine on the luminous indicator board and has decided to explode a mine, he switches the precision indicator in circuit with each of the four mines of the square indicated. As each mine is momentarily connected with the precision indicator a reading is obtained, this reading indicating to what extent each microphone is being affected, which in turn indicates the close proximity of the submarine.

It is a simple matter, according to Mr. Chandler, to determine upon the mine nearest the submarine, which is then exploded. Inasmuch as a 500-pound mine exploding 50 feet away from a submarine has a destructive effect sufficient to destroy a submarine or at least put it out of action, it is evident that the submarine has a poor fighting chance once its location is revealed by the eavesdropping mines. Incidentally, Mr. Chandler's system can be used as a protection against surface craft of all kinds, the operation being the same. In this manner it becomes impossible for surface ships to dash past an electrically-controlled mine field during fog or at night.

The detection of submarines from the air is being reserved for another article which will deal at length with this feature of the anti-submarine campaign.

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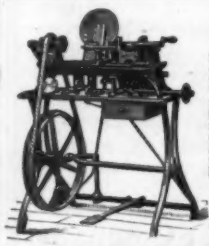

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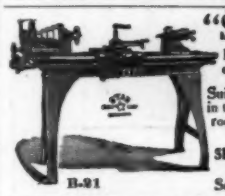

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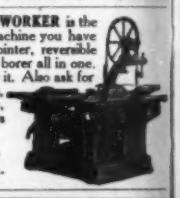

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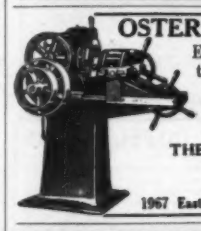

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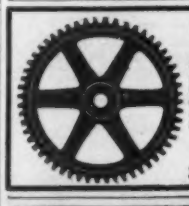

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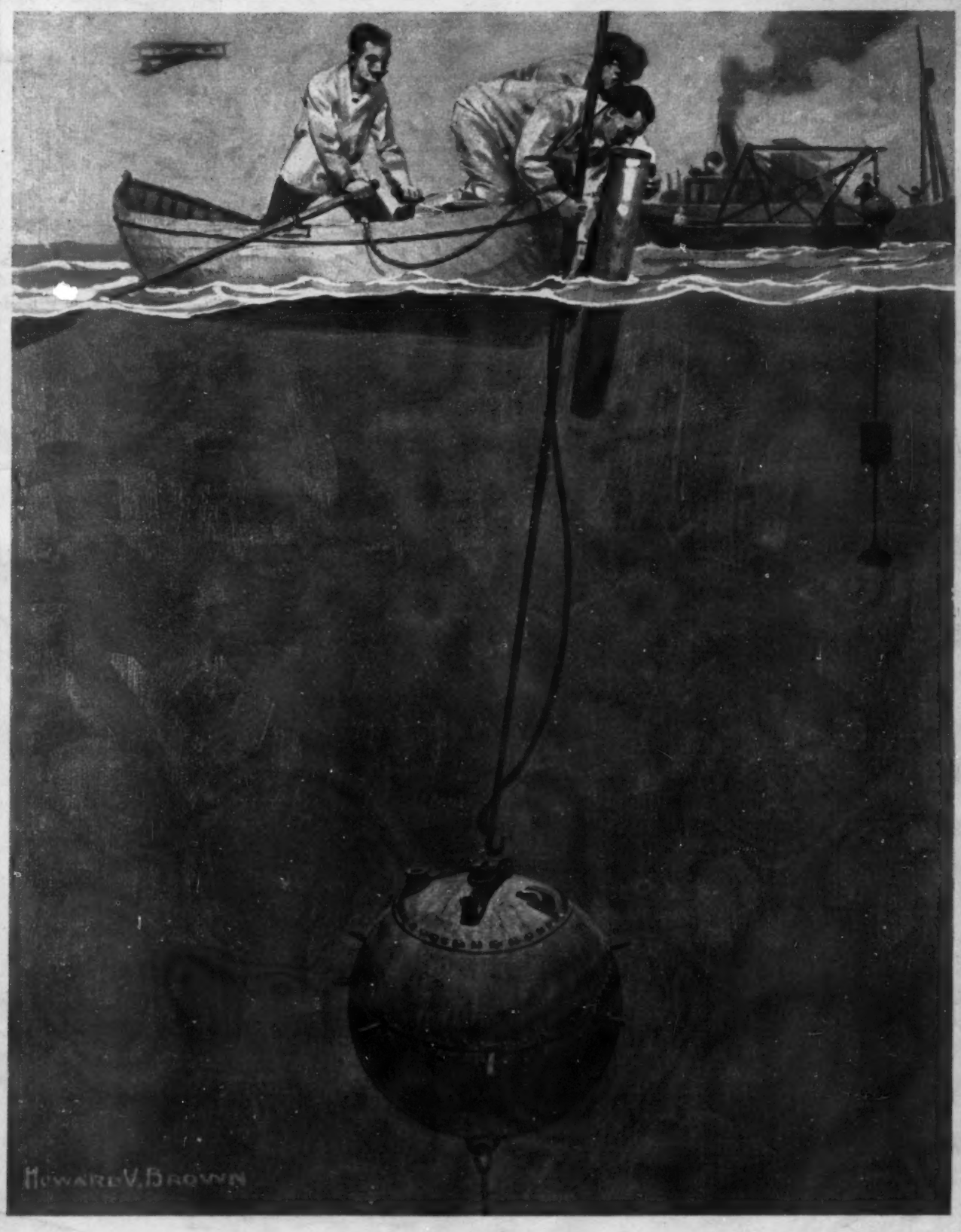

CLEARING AN ENEMY MINE FIELD—HOOKING THE HOISTING CABLE TO A MINE—[See page 24]

July 14, 1917

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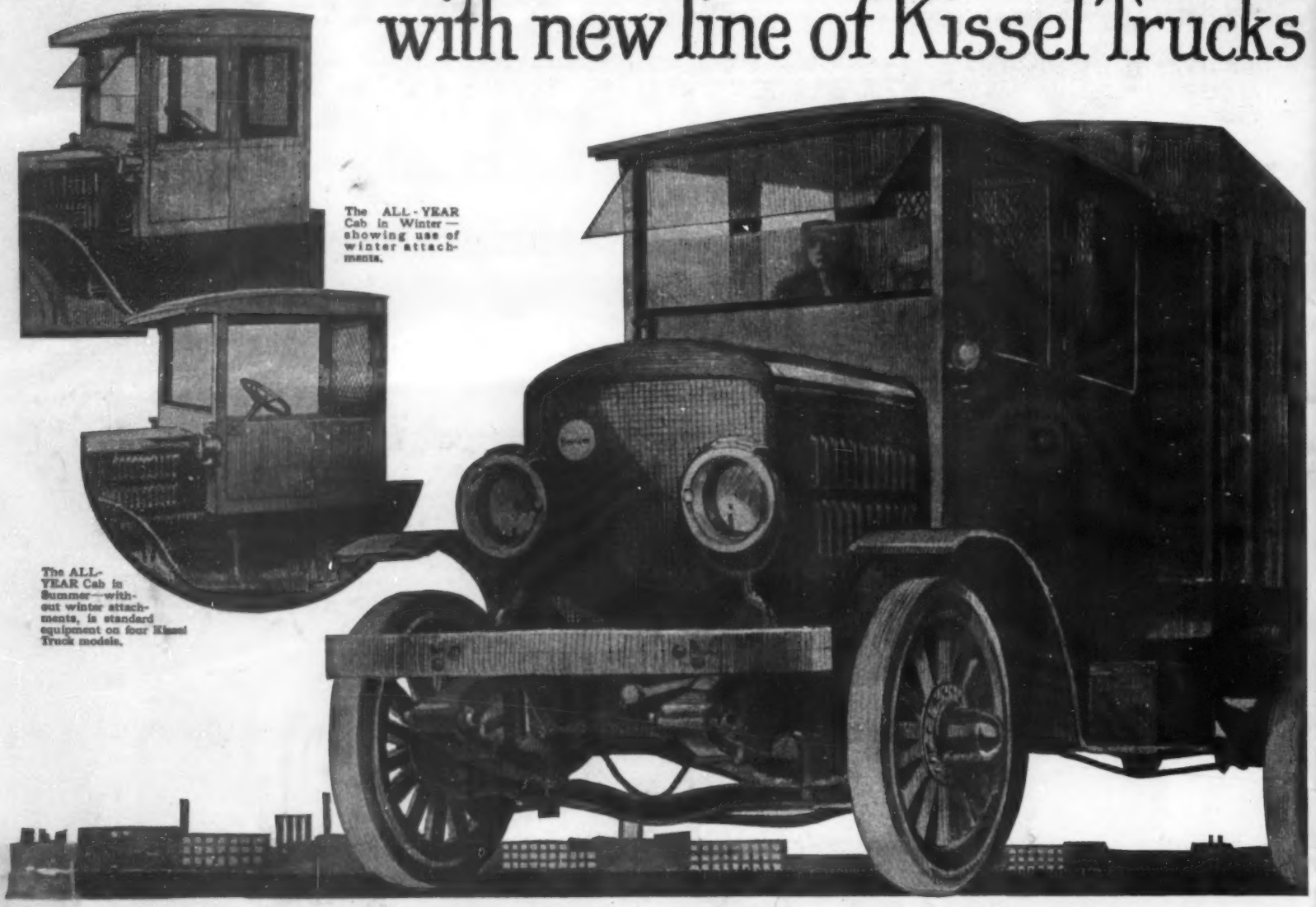

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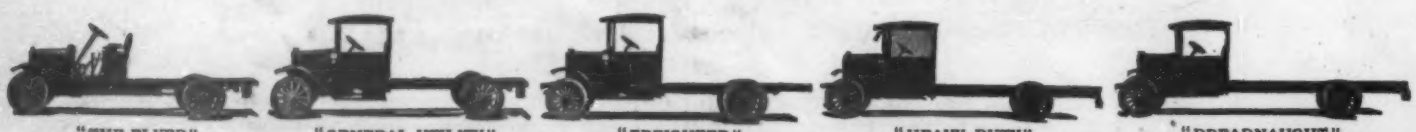

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